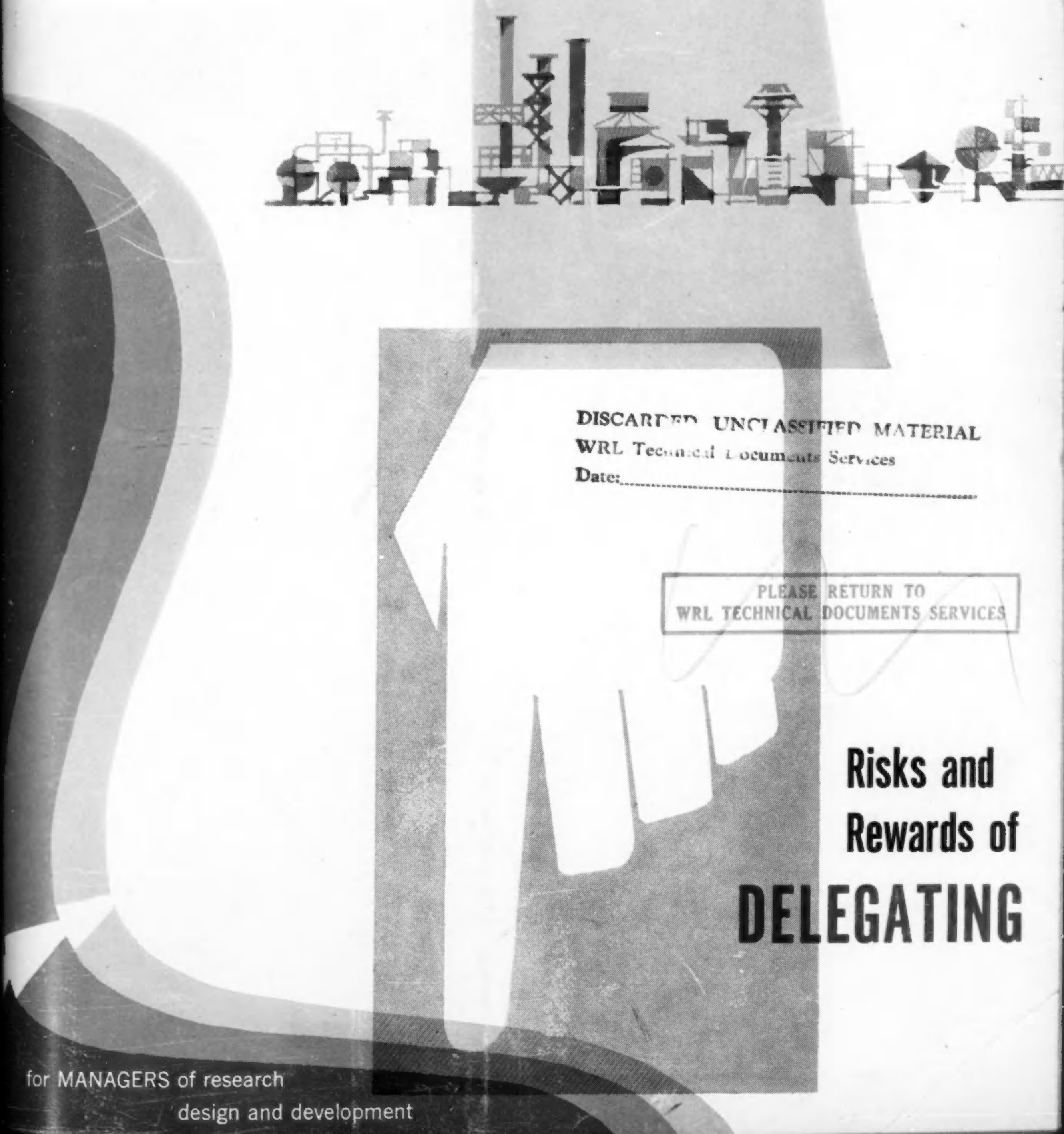
JUNE 1957

Research & Engineering

R/E

The Magazine of
TECHNICAL MANAGEMENT



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for MANAGERS of research
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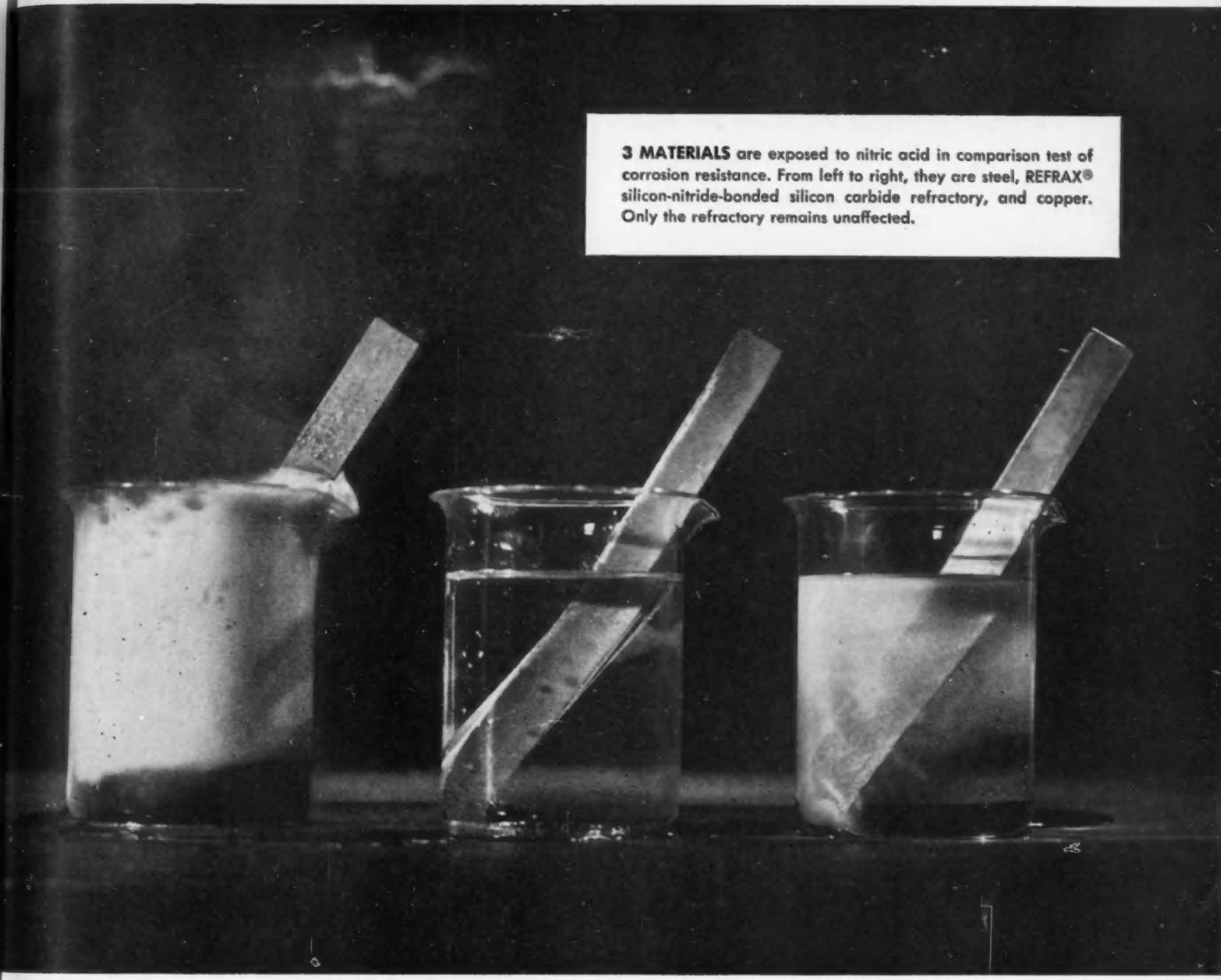

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Research & Engineering

The Magazine of
TECHNICAL MANAGEMENT

JUNE 1957
VOL. III, No. 6

for MANAGERS of research
design
and development

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Letters

Please send all letters to the editor to our editorial offices, 77 South St., Stamford, Conn. Correspondents should include their titles and company names. However, names will be withheld on request.

See Here, Mr. Alsop!

NEW YORK, N. Y.

It seems unfortunate that a journalist of Mr. Alsop's perception should, in matters of science, show himself to be as naive as the next man who, in his education, has succeeded in steering clear of any contact with the natural sciences. The result is that while appearing to make a very good point in stressing the anti-scientific, pro-gadgeteering mentality of our Department of Defense, ably led in this respect by Secretary Wilson, he actually misses it by showing how far he is from a real understanding of the issues involved.

(In his column in the N. Y. Herald Tribune on April 17, 1957, Stewart Alsop cited as an example of "basic research" the discovery of Dr. Mac Van Valkenberg that pellets traveling at 8500 miles an hour or more do not penetrate deeply into a wax target but explode and disintegrate on impact.—Ed.)

Mr. Alsop's example of a "basic" research problem is neither very basic nor particularly exciting. It seems to be of the type of research project which, since something is shot at something else, is attractive to the military research administrator and therefore most likely to be supported. Nor are the results that are so breathlessly reported by Mr. Alsop unexpected to the research worker familiar with the particular field: the velocity effects in the mechanical response of materials are reasonably well known and a sharp transition between the phenomena of penetration of the "target" on the one hand, and disintegration by impact of the plastic "shell" on the other, has most likely been expected by the University of Utah scientist before starting his experiments. The "magic" figure of 8600 miles per hour can be "magic" only to a very naive soul; a minimum understanding of what is involved would have made Mr. Alsop understand that even by slightly changing the size of the plastic pellet alone this figure will necessarily change.

Now, it is certainly no reflection on Mr. Alsop's qualification as one of our most clear-headed political journalists that he fails to grasp the facts involved in a simple, rather routine type of experiment. But why does he write about it so breathlessly and attempt to prove a perfectly good point by the wrong argument?

Our Defense Department is run by a mixture of "practical business men" and men with "military minds". To men of this type any new thought is automatically "nonsense". They would not be what they are, if it were otherwise. If, for instance, they had been in charge of directing physical research, they would certainly not have been able to see the necessity of any research in nuclear physics and would probably have sent Professor Niels Bohr to the psychiatrist if he had tried to convince them 20 years ago that such research should be supported by their organizations.

Fortunately, they have not been in charge; moreover, we are not alone and we have no monopoly on shortsightedness. The "military mind" is quite international. In fact it is quite likely that we are better off than other nations, because the strong influence of the "business mind" in our military establishment is a moderating factor being, in general, less rigid and (perhaps with the exception of Mr. Wilson) less arrogant than the "military mind" or the mind of the "party boss" of whatever denomination. In the long history of relations between the scientist and the "military mind" in all nations we have probably established a record of cooperation, in spite of numerous examples to the contrary. What then is the problem?

It is *not* that Mr. Wilson is not interested in finding out "why the grass is green"? This is really none of his business, unless he happens to have a military problem of camouflage on his hands. The problem appears to be that the order of magnitude of the funds involved has become fantastic and that the Defense Department has practically monopolized the funds available for research in general, without, at the same time, being made aware of this fact by Congress, without being specifically told that the support of basic research is an important part of its obligation. As long as the Defense Department itself has to decide how to divide its "research" funds between development, research of immediate military utility, research of long-range utility and "basic" (meaning research the use of which the "military" and "business" mind is unable to grasp), it is surprising that so much of this money finds its way to support research of a more basic character, probably only because some of the military research administrators are scientists who find ways to camouflage some basic problems under the guise of "applied research".

The fault is not with Mr. Wilson, or any Secretary before or after him. The fault is with Congress, the fault is with Mr. Alsop and other journalists who have the public ear, for having failed to understand that scientific research in our society has a right of existence of its own, independent of its potential use, present or future, for any military or other purpose. Why should it be supported by the Defense Department rather than by an agency administered by qualified men? There is no reason to blame the Defense Department officials; no scientist in their position could probably do better or as well even if he were interested in trying. Why not blame ourselves for expecting them to do the things which are none of their business, simply because we have failed to grasp the problem and to provide the means for its effective solution.

A. M. FREUDENTHAL
PROFESSOR OF CIVIL ENGINEERING
COLUMBIA UNIVERSITY

Tips From Readers

SCRANTON, PA.

I note in your April issue that my former colleague, Mr. H.A. Mereness is looking for a means of measuring small areas. The following is suggested as a procedure of reasonable precision.

Take an ordinary lecture type projector of the kind used for slides, pamphlets, etc. Place the sample on the platform used for reflective projection and throw the image on the usual screen. A planimeter measurement of the image may then be made.

To obtain the factor of magnification and avoid distortion, the sample may be laid on a grid of known dimensions such as millimeter graph paper. If this is not feasible, a reticle with a known grid, such as a Whipple disk, may be used in the projector lens system.

W.J. HART
TECHNICAL DIRECTOR
THE JAUNTY FABRIC CORP.

POTTSTOWN, PA.

In the fabrication of large reflectors for solar furnaces I have been entertaining an idea similar to the "concave plastic drumhead" of Mr. R.B. Dean.

I would propose an inflated lens-shaped reflector of transparent plastic having one of the inner surfaces coated with a reflecting material. The balloon could be suspended by springs within a ring and the focal length adjusted by controlling the volume of pressure of air in the bag.

Of course, this sort of reflector would not have optical qualities but ought to be good enough to concentrate sunlight.

WILLIAM A. PETROSKY
RESEARCH ENGINEER
KAWECKI CHEMICAL CO.

NUTLEY, N.J.

In reference to a letter from R.B. Dean of the Borden Company, which appeared in the April issue of R/E, I suggest that Mr. Dean contact Mr. W.S. Pajes of 636 West 136th Street, New York City for further information pursuant to his inquiries.

Mr. Pajes has a patent application and a two foot model of a plastic elastic reflector such as Mr. Dean refers to.

We have examined Mr. Pajes' model and found that the reflector's elastic membrane corresponded very closely to parabolic template.

It is not readily apparent, however, whether this holds true for large size parabolic reflectors, since the weight of the membrane would probably have some effect on the curve.

A.J. LOMBARDI
PROJECT ENGINEER
FEDERAL TELECOMMUNICATION LAB.

Yeas and Nays

CINCINNATI, OHIO

A bouquet of camels' hair brushes to your artist, whose illustrations of your articles provide the finishing touch to a great publication. How about a biographical sketch on this person whose humour matches his imagination and skill?

W.H. BREUNIG
THE BALDWIN PIANO CO.

Recipient of this hirsute offering is R/E's Art Director, Paul Arlt, free-lance artist and cartoonist. His work has appeared in Fortune, Harper's Magazine, Newsweek and other publications. A New York City boy by birth, Paul now lives in rural New Canaan, Conn., with his wife and teen-age daughter. —*Ed.*

ROCHESTER, N.Y.

I have enjoyed "The Klugemacher's Dilemma" so much that I just had to write and tell you how glad I am you carried it. I hope that you will go on to write more of the same.

RICHARD D. BOUTROS, V.P.
DIRECTOR OF ENGINEERING
MIXING EQUIPMENT CO., INC.

MIDLAND, MICHIGAN

Referring to Dr. Seaton's letter in April R/E, on the subject of promotion of engineers into management, I give up. What is the "prime characteristic for engineering" which is possessed by "less than one man in four." Also, what are the "thirty-five other characteristics"?

R.E. GREENHALGH
PROJECT ENGINEER
DOW CORNING CORP.

Technical Writing

CAMDEN, N.J.

Your article on "Authorship & Company Policy" (April 1957 issue) was timely and interesting. I would like to suggest that another factor in the apparent de-emphasis on publishing might be recent trends in governmental and judicial patent policies which seem to place a premium on secrecy in research, and on the quickie, slightly-improved product which catches its share of the market and is almost immediately superseded. See DUN'S REVIEW, April 1957, pg. 52.

CHARLES H. CHANDLER
RADIO CORP. OF AMERICA

WILMINGTON, DELAWARE

Just finished reading the item "Authorship and Company Policy" in the April 1957 issue of your magazine. I enjoyed the item, but shuddered at the statement in the first line of page 32: "These men, usually amateurs in science, are specialists in language."

Heaven preserve us from the "technical editors" who are "amateurs in science." If anything, the technical editor should have a broader background in science than some of his more specialized colleagues.

R.E. SPEERS, EDITOR
ENGINEERING DEPARTMENT
EXPERIMENTAL STATION
E.I. DU PONT DE NEMOURS & CO.

DEVELOPMENTS

Versatile Material from Glass

A new family of basic materials, harder than high carbon steel, lighter than aluminum and up to nine times stronger than plate glass, has been developed by Corning Glass Works. Bearing the name Pyroceram, the product according to Corning researchers represents one of the greatest technological advances in glass research since the discovery of heat-resistant borosilicate glass early in the Twentieth Century. By a new manufacturing process, noncrystalline glass is turned into a hard, non-porous crystalline material.

Certain types of Pyroceram keep their strength at temperatures as high as 1300°F., according to Dr. William H. Armistead, company vice president and director of the research and development division.

"Unlike most high-strength, high-temperature crystalline materials," said Dr. Armistead, "Pyroceram has great flexibility in forming. It can be made into large or complex shapes by any of the known glass forming techniques."

At a press conference announcing the new development Corning's president William C. Decker pointed out the wide variety of end products that could come from the new family of materials. One of the first uses will be for radomes, or nose cones, for guided missiles.

"It is doubtful whether there is any other material which meets the specifications of the radome with regard to strength, hardness, temperature resistance and dielectric properties," Mr. Decker said. "Also, in the case of the new airplanes flying at supersonic speed, Pyroceram can bring the desired properties of resistance to high temperatures and great strength to plane areas where such properties are essential."

Although the new material has only been produced in pilot plant quantities to date, Mr. Decker pointed out that certain cost advantages are apparent to their development engineers. While more expensive than glass, Pyroceram is expected to be much less costly than stainless steel. The Corning president noted two cost advantages for the new material: the batch materials are not costly, and Pyroceram can be shaped while molten by regular glass making processes.

Besides its military and aeronautical applications, Mr. Decker anticipated that Pyroceram would find a place in architecture, especially for curtain walls, in the chemical and oil refining industries, and even in the home, for such items as kitchen range tops.

Invented by Dr. F. Donald Stookey, manager of the company's fundamental chemical research department, the new materials are melted and formed like glass, with each batch containing one or more nucleating agents. Subsequent heat treatments cause the nucleating agents to form billions of submicroscopic crystallites. Pyroceram can be made opaque or it can be transparent.

Girding for Increased Automation

Congress must squarely face the fact that automation is essential to our domestic economy and national defense and that there are inadequacies in our instrumentation program due to insufficiently-trained and thinly-educated manpower. Testimony stressing the urgency of the situation has been laid before the Subcommittee on Economic Stabilization of the Joint Economic Committee of Congress by Robert T. Sheen, 1956 president of the Instrument Society of America, and a corps of distinguished technical men from key industries.

Four specific needs mmust be met, Mr. Sheen testified, to correct the present situation.

1. Education of the current work force.

2. More engineering and science graduates.

3. Increased availability of instrumentation services.

4. Broader communications.

"The greatest and most urgent need," Mr. Sheen said, "is for an education of our *current* work force—for the workers *now* in industry. Technical institutes and vocational high schools either are not aware or do not have facilities or staff to train the great host of sub-professional personnel required." Yet it is imperative, he noted, that designers of machinery and processes "keep up with the advances of fundamental and applied knowledge in the automation field."

To satisfy the four enumerated needs, the ISA president suggested a broad program that would include improvement of curricula and training of high school teachers, development of institutes for vocational training, establishment of collegiate engineering extension services, and effective use of military training for industrial occupations. He also recommended enhancement of the programs of the National Science Foundation and the Foundation for Instrumentation Education and Research, a more active role by the National Bureau of Standards in communication of information, and systematic military-industrial cooperation.

Thoughts on Thinking

Can engineers be taught to think more creatively? If so, just what disciplines and procedures lead to creative thinking? Also, what is the nature of creative thinking?

New light on these questions last month came out of a Seminar on Creative Engineering sponsored by the Industrial Education Institute and conducted by two engineers of the General Electric Company, David L. Purdy, Manager of GE's Engineering Program Courses, and Perry R. Mason, Supervisor and Development

Engineer, Creative Engineering Program. The talks were based on an educational program which has been conducted by GE for the past 20 years.

Deliberately sidestepping the question whether creative ability is innate, and how much of it a given individual has, Mr. Purdy disclosed that General Electric in its Creative Engineering Program had developed a procedure for helping individuals to utilize their creativity to maximum capacity.

The two GE engineers' outline for creative thinking, which they equated pretty much with problem solving, involved a series of nine steps: 1) Problem recognition; 2) Definition; 3) Search for solutions; 4) Organization of ideas; 5) Evaluation; 6) Selection; 7) Demonstration; 8) Presentation; and 9) Execution. Although it might be argued that the last three or even four steps are not truly "creative", this chronological procedure has proven of great value to General Electric in its search for new ideas and Purdy and Mason, in a set of examples, demonstrated how it can be used to solve a wide variety of technical problems.

Of paramount importance is the need to recognize and carefully define and delineate the problem itself. Without knowing what we are looking for, it is obvious that no solution can be adequate. Though this is simplicity itself, many engineers fall into the habit of not sufficiently scrutinizing and defining the problems they are called upon to solve.

Another pitfall of educated specialists is to scrimp on the search and origination of new ideas. All of us being basically lazy, it is a normal tendency to follow mental avenues of the past, excluding the unusual, the far-fetched, the fantastic—out of which often come solutions to problems. In discussing the elements of creative thinking, Mr. Purdy urged that a number of hypothetical solutions be uncovered before any attempt is made at their evaluation.

"It is common practice," he noted, "to hypothesize or originate one possible solution and to continue through to a complete solution without further origination—this single purposeness often resulting in products or processes which do not withstand the buffeting of competition."

The Seminar on Creative Engineering, one of a series being sponsored by the Industrial Education Institute, went into all aspects of helping engineers to be "more skillful in the

use of their imagination and ingenuity." The 150 technical managers attending the morning and afternoon sessions were asked to solve certain illustrative problems; and their procedures, ideas and solutions were then discussed in relation to the concepts evolved under the GE program.

Spiraling Market for Transistors

Use of germanium and silicon transistors will extend into practically every phase of American life during the next few years. The tiny electronic devices, which perform many of the functions of vacuum tubes, already have found a secure position in military equipment, commercial and industrial uses, and in consumer goods such as transistorized radios. Applications of the near future will include missile receivers, navigational radars, fire control equipment, flight control systems and autopilots.

Consumer applications will involve everything from the family car to children's realistic toys. An example is the transistorized fuel injection system, which some automotive experts believe will obsolete today's carburetor fuel injection systems in passenger cars and trucks within a few years. A suggested toy envisions a small, transistorized piano that would play through the radio, giving the diminutive piano a sound comparable to the real thing.

Production of transistors for military, industrial, commercial and home entertainment uses is expected to reach 125 million units in 1959, as compared with the 26 million units anticipated for this year, according to William J. Peltz, vice president and general manager of Philco Corporation's Lansdale Tube Company Division. Mr. Peltz based his forecast on a recently-released market survey made for Philco by the Stanford Research Institute, in which 80 companies in the electronic field cooperated. Estimates resulted from actual production potentials of these companies and foreseeable needs.

"The dynamic nature of the transistor business," Mr. Peltz said, "will require continual updating and re-evaluation of the markets for these devices." He noted that the Stanford figures rely on markets that exist today and uses which will be developed and in production by 1959 and do not represent the potential of new applications that have not been fully developed or whose need has not yet been explored.

As between germanium and silicon transistors, the Stanford report indicates that germanium has the higher growth rate today but that by 1959 the picture will be substantially altered. For example, the military is expected to need some 5 million germanium transistors in 1957, and in 1959, close to 27 million. Military use of silicon transistors will be about 2 million units for the current year, but will jump to more than 18 million units by 1959.

Noting the wide variety of new markets earmarked for transistors, the report states that "this industry is leaving the infant category and is becoming a fast-growing adolescent. Sudden and unanticipated expansions are the rule rather than the exception . . . Just how dramatically the transistor market will grow depends largely on price and the success in building transistors that will meet increasingly stringent technical requirements."

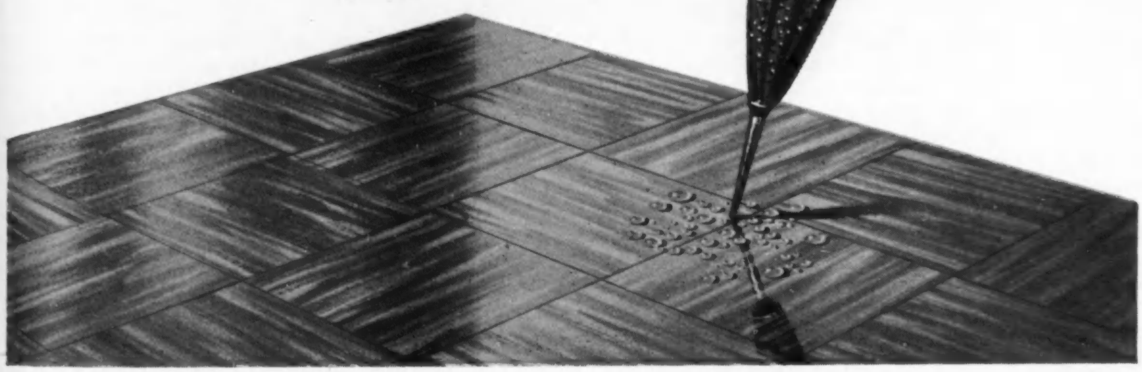
Utilization Research Urged

A greatly increased research program aimed at the further industrial use of a wide variety of farm products has been recommended by a bi-partisan commission set up by President Eisenhower last year. In an interim report recently presented to Congress, various research projects that would convert surplus crops into plastics, coatings, paperboard and chemicals are detailed. Recommended is "a comprehensive program for research, process development, pilot-scale tests, market study, trial commercialization, and educational work" that would cost at least three times the $16,145,000 being spent by the Federal Government for utilization research during the current fiscal year.

Polluting the Atmosphere

The recurring controversy as to whether nuclear explosions and industrial smoke affect weather conditions came into the spotlight again late in April, when Dr. Ross Gunn, director of physical research for the U. S. Weather Bureau, spoke at the 94th annual meeting of the National

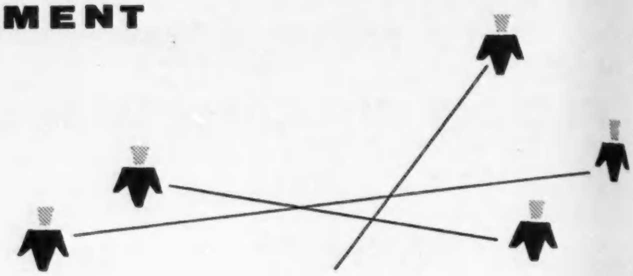
(Continued on page 46)



TECHNICAL MANAGEMENT

Merritt A. Williamson

While Dr. Williamson is vacationing, his column this month is taken over by an associate, Arnold Addison, Personnel Director, Ordnance Research Laboratory, The Pennsylvania State University.



ARE ENGINEERS REALLY DIFFERENT?

At the present time, because of a serious shortage of engineering manpower, we have been concentrating our efforts on getting our share of such manpower, while at the same time analyzing all our actions in terms of holding what engineering manpower we have. Such a program is essential, but we must guard against any over emphasis at the expense of other groups in our organization.

Recent surveys and magazine articles give us a keen insight as to what the engineer expects from his employer. In essence, engineers are no different from other people—they all have opinions on how things should be done. The difference is that engineers can use the slide rule to prove their points.

Attitudes toward Personnel

Generally speaking, engineers exhibit two distinct attitudes in relation to personnel administration. First, there are those who just do not care, so long as what you do does not interfere too much with their lives as scientists. Such engineers are happy to have someone else handle personnel details, which would only clutter up their lives if they had to take care of them. From these men I have had such back-handed compliments as, "You are the least obnoxious extrovert I have ever known," and "You have a most difficult job, with many problems. I'm so glad you are here to take care of them for me."

In a second category are engineers who make it a point to become authorities on all subjects, including personnel administration. Such men are not sympathetic to personnel departments or programs. Not that they would prefer to work out personnel practices and procedures themselves, but they will not accept the fact that these things might better be done by personnel professionals.

A personnel director does not successfully fight this attitude, for too often we are outnumbered. The order of the day is to outmaneuver. This is done by planting the seed in the scientific mind, permitting sufficient time for germination, fertilizing by frequent reference to keep the seed alive, and finally by being perfectly astonished and pleased that the seed you planted bears fruit in the form of a proposal by the engineer for a new or better personnel procedure or practice.

Engineers Must Be Sold

For the most part the difference between engineers and non-professional workers rests on working habits. Both in college and later in his professional life, the engineer has been trained to check and double check all the data he uses. This means that he will not accept what we in personnel offer until he has followed his scientific approach to make sure he is not just being "sold a bill of goods". However, as Peter Drucker has pointed out, (in *Harvard Business Review*, May 1952) this does not mean that this professional man should be tagged as an individualist, since quite often he is quite capable of working as a member of a team. But it has been pointed out that he may not take kindly to modern organization. He may insist on having complete control of the entire job.

Too often we put the engineer in the category of a "problem child" who is forever in need of some type of corrective institution. Over ten years ago we talked about foremen as the "forgotten men" of management. Then followed packaged training programs, too often patterned after what some other organization found successful, which in fifteen conferences was supposed to bring the foremen up-to-date and place a wreath on his head at the same time. Not too long after this we talked about "middle management" being the forgotten personnel. For the last several years we have been busily engaged in analyzing the engineer to the point that we may have created a monster in the eyes of top management. It isn't fair to top management or the engineer.

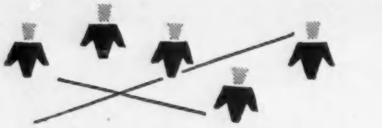
Today's Problem Child

Let's look for a moment at the engineer in his work situation. It has been said the engineer takes a dim view of the so-called administrative processes. He may dislike his supervision, preferring a senior-junior relationship to supervisor-subordinate relationship. He may even dislike the red tape necessary in an industrial, governmental, or university organization. Some of his ideas in these matters may well be worth considering in the interest of streamlining relationships and practices within a given organization.

On this point, is the engineer different than any other worker? Not all supervisors would win popularity contests. Are foremen more sympathetic to the red tape procedures that most organizations have? As for the rank and file worker, is he one to be excluded from the groups that have prejudices against supervision?

Workers, professional or non-professional have their prejudices. Something can be done about them when they are known. The approach to each group might be slightly different, but the method of approach does not necessarily mean that engineers are different from other groups.

(Continued on page 12)



(Cont. from p. 10)

Desire for Professional Recognition

Perhaps the greatest single gripe the engineer has is related to his desire for professional recognition, both inside and outside of the organization. This gripe is no different than one would expect to find from a foreman or a worker. The foreman expects that with effort on his part he may expect to obtain a supervisory position at a higher level, while at the same time the worker wants to feel he too can move up to a foreman's position. The degree of recognition may differ, but the basic requirement of being recognized for what one accomplishes is inherent in most of us.

The engineer's quest for the "right" work assignment makes him no different from others who work for a living. We cannot expect an engineer to be any happier doing a technician's work than we can expect a tool and die maker to be happy as a third class machinist. Many corrective measures have been taken to assure that engineers are used on strictly engineering jobs. The fact that the engineer has insisted that this adjustment be made makes him no different than other types of workers who insist they be used at their highest skills.

In a rather extensive survey entitled, "How to Attract and Hold Engineering Talent" prepared by Professional Engineers Conference Board for Industry in cooperation with the National Society of Professional Engineers, it was emphasized that the engineer wants security, opportunities for advancement, and a sense of achievement.

According to this survey it is important for us to realize that many of the engineers coming into the profession today are children of the great depression of the "thirties". Many of them still remember its dislocations and effects, perhaps on their own families, and they want a safe niche for themselves in industry. We are faced with the same problems with non-engineering groups, for as Scott, Clothier and Spriegel state in their book, *Personnel Management*, "With the increased urbanization of our country and the prolonged depression of the thirties still lurking in the minds of most workers the desire for security occupies a prominent place in the hopes of our people."

Advancement Opportunities

It is difficult to separate the desire for security, opportunities for advancement, and the desire to feel a sense of achievement for they are all closely knitted together. It is most unrealistic to consider that the engineer is more concerned with such matters than workers in any other group. The definition of security is to be considered in the broadest sense, for it should include security for opportunity. Security is therefore unquestionably linked with opportunities for advancement, following which the much needed desire for a sense of achievement can be fulfilled.

Nor can we see a difference between the desires of the engineer and others on these points. Unless our programs are geared to fulfill these desires for security of opportunity, so all concerned may feel a sense of achievement, we can expect morale problems. This has been summed up by Scott, Clothier and Spriegel in the statement, "A feeling on the part of workers that loyal and meritorious service will be recognized provides a strong incentive to positive action. Nothing will destroy this confidence quicker than nepotism, internal politics, or any type of favoritism."

Three Personnel Considerations

Regardless of the classification of those who work, personnel people must be concerned with three factors if we expect to have satisfied employees in our organizations. These factors are applied equally to members of top management and the rank and file worker. In the first place, we must be in a position to know and concern ourselves with the individual's ability. Secondly, we must know what his interests are. Thirdly, we must know what opportunities are available in our organizations which will permit the effective utilization of the individuals ability and the fulfillment of his interests. If we expect to have in our employ an effective satisfied worker, we must find the balance of these three factors. Admittedly, this is not an easy task, but our approach is

ite similar whether we are con-lering the rank and file worker or e engineer. There is little difference.

Outside of the work situation, the gineer is no different from anyone se. His interests may differ slightly, t basically he acts like anyone else. e usually is, or aspires to be, a me owner. When he is, he will end an abundance of time making is home and its grounds most pre-ntable. He is interested in his com-unity, and wherever and whenever ssible will make a contribution to mmunity life. You may find him on hool boards, volunteer fire depart-ents, Boy Scout Councils and other mmunity committees. He is usually member in good standing in his hurch. In brief, the engineer takes is place beside others in the various hases of life outside of the work tuation. In such situations he may fer a keener mind, but in terms of ervice he is no different than others.

In summary, therefore, it does ap-ear that we ought to stop consider-g the engineer as a problem child ho has to be handled differently. Let s recognize that what motivates him uite often will be exactly the same actors that motivate others. Unless e begin to change our thinking in hese matters, there is danger that he engineers will believe what many ave been saying about their being ifferent. If this ever happens, we are n trouble.

Secondly, our programs must be rganized and operated for the benefit f all groups of workers. Too much mphasis on a single group can only esult in unhappiness in others. If e are concerning ourselves with the asic desires, ambitions, likes and islikes of one group, let us also be qually concerned with the motivat-ng factors of all groups. Some may e engineers, some foremen, others orkers, but all are employees.

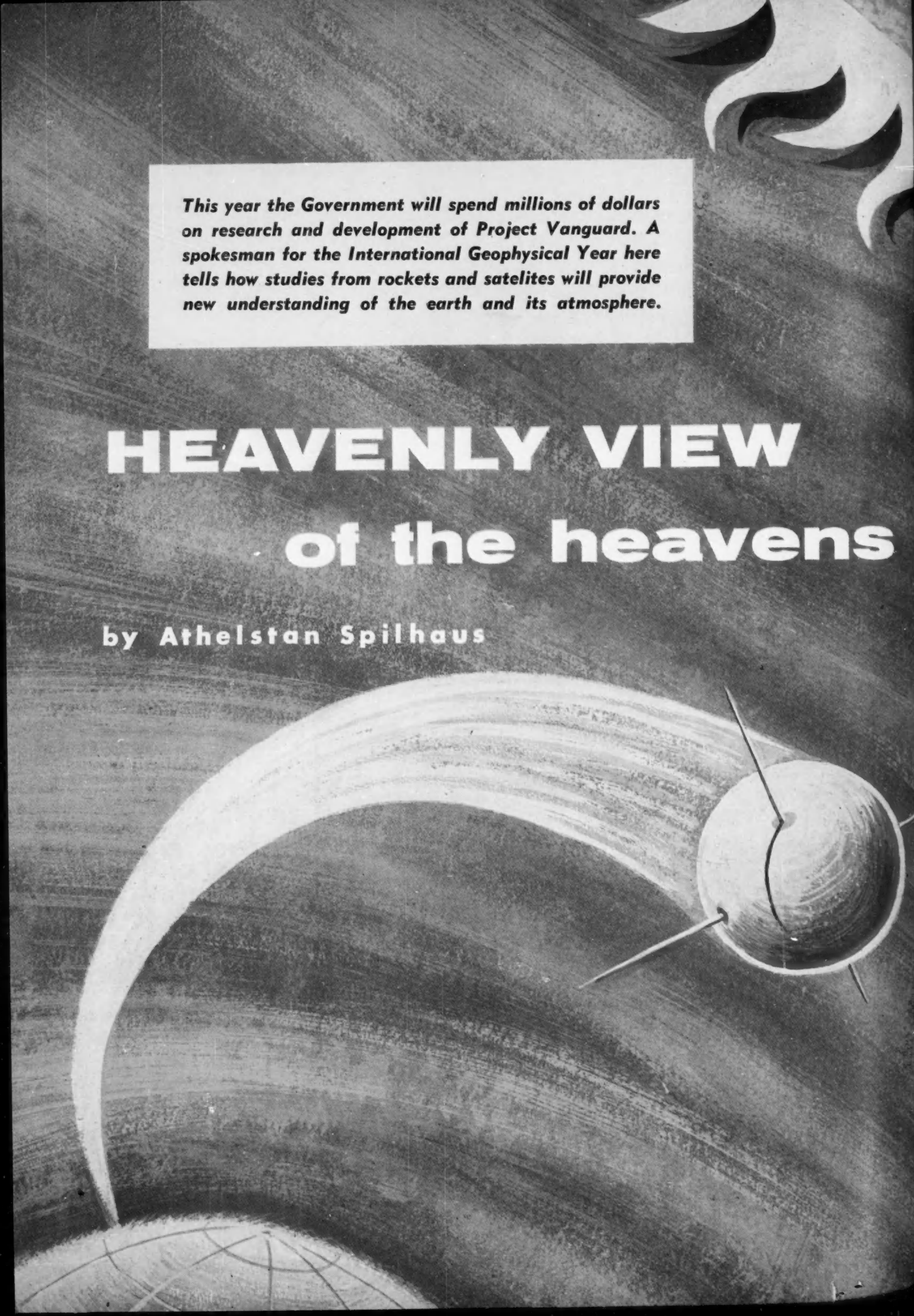
ERRATUM

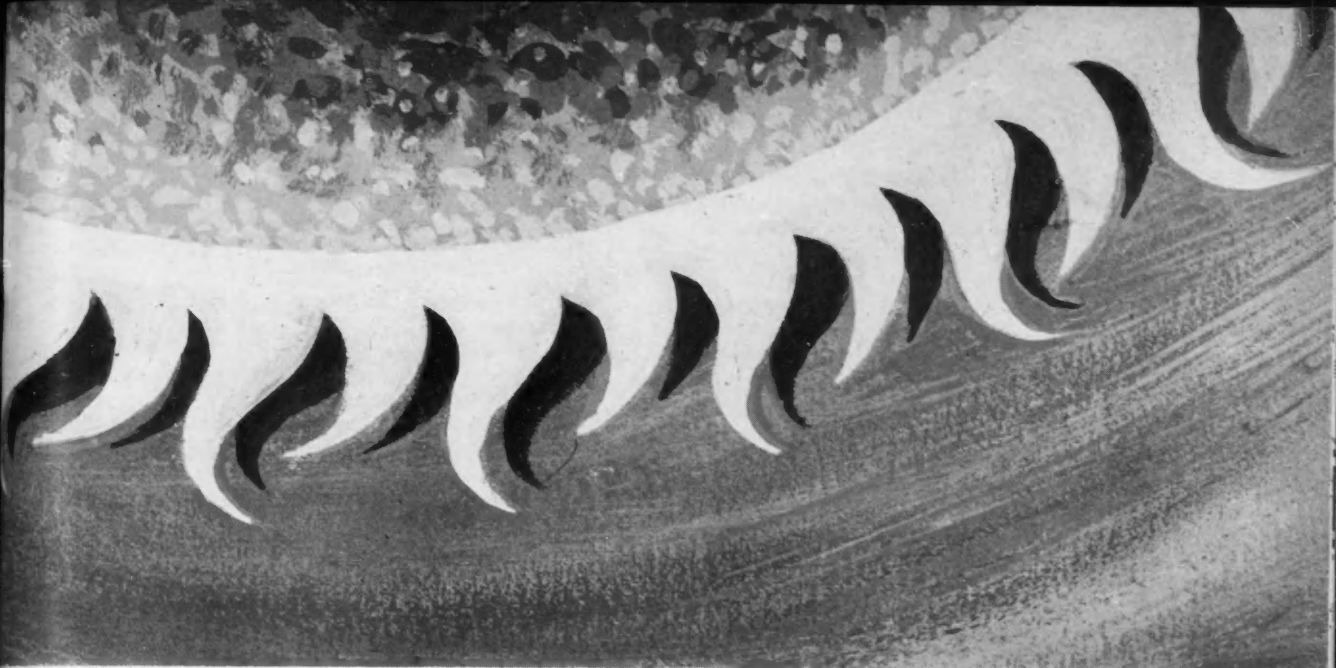
In our discussion of Soviet vs Ameri-an technical education ("Education for ngineering — U.S.S.R.", April 1957, age 13) we regretfully misidentified r. Roger Adams, Research Professor f the University of Illinois, as being ith Chicago University. Also, con-rary to what we implied, Dr. Adams as made no statement on the compara-ive value of Russian engineering schools. e spoke as a chemist at a recent gov-ernmental meeting and expressed his elief that the Russians would not catch p with the United States "in either ure or applied chemistry during the ext ten years."

This year the Government will spend millions of dollars on research and development of Project Vanguard. A spokesman for the International Geophysical Year here tells how studies from rockets and satelites will provide new understanding of the earth and its atmosphere.

HEAVENLY VIEW of the heavens

by Athelstan Spilhaus





ANYONE WHO IS FAMILIAR with the program of the International Geophysical Year is struck by the fact that the engineering tools which we use are all virtually new. Photo electric cells, miniature radio and television have been developed only within the last twenty years or so.

Just twenty-four years ago at the time of the Second International Polar Year in 1933, we had only begun to gain a third dimension into geophysics. That is, we had just begun to directly observe elements of our environment not right on the surface of the earth. Airplanes and balloons had given us access to the sky; submarines and deep sea measurements offered us a look into the ocean, and seismic techniques were starting us on our exploration of the lithosphere.

The Quickening Pace

In the forties, electronics, radar, and submersible vessels, enabled us to reach even farther. No part of the surface of our planet remained geophysically unknown. One great example of this progress was the calm occupation of the Antarctic Continent, based on the tracked mechanical weasel and a host of wartime developments in clothing, food, heating, and communications.

Instruments which extend man's own senses made possible deeper descents into the ocean and the lithosphere.

In the upper atmosphere engineering vehicles carried man in safety to places which his frailty had formerly made inaccessable.

But in spite of all this, the sum of these efforts could be likened to peripatetic attempts of microbes peering out of a thin film of fluid spread over the surface of a globe. The rocket and its electronic payload, the satellite, changed all this. They have become the means by which men will escape from this film. They provide the real unlimited third dimension, both for the study of our own earth and the better understanding of the mechanism of the heavens.

Goals of the Geophysical Year

We can best appreciate the role played by rockets and satellites when we consider what originally impelled us to found the Geophysical Year.

The first aim was to observe the sun above the obscuring layer of atmosphere. Because the sun influences so many of the features of our atmosphere, the central common denominator of most of the programs is the observation of solar activity. Indeed, this period 1957-58 was chosen because it will be one of near maximum sunspots. No other such opportunity of maximum sunspots will occur until 1970. One might say that the sun itself set the date.

Another important reason for the Geophysical Year was to obtain a truly *global* view of the earth. Now, no single observer on earth can at any one time see the larger events that take place in our environment. A global view of the atmospheric circulations on Mars is more readily available than that on earth. One way to obtain an over-all view is to space observers all over the surface of the earth, and IGY is doing this. But another way is by instruments in a satellite, or by photographing the earth from several thousands of miles at different wave lengths from a Vanguard-like rocket fired straight up.

A third reason for the selection of the programs was to explore those regions at the surface of the earth where greatest ignorance exists—the most inhospitable regions: the ice islands in the Arctic and the coldest continent, Antarctica; the deepest areas of the sea; and the highest parts of the atmosphere.

Finally, we were interested in studying the interactions of the various forces of nature, one with another.

These group into three general categories:

- . the physics of the upper atmosphere
- . surface and interface geophysics
- . the earth—its crust, interior and shape

The Upper Reaches

The upper atmosphere is the region where many fundamental atmospheric processes originate. The flares and eruptions of solar activity have a marked and immediate effect on ionosphere, on aurora, and on geomagnetism. Above the protective shield of denser atmosphere the satellite project will expose instruments to the sun's full blaze. From there, we will have a chance to investigate cosmic rays, air density, inter-planetary matter, and the storminess of the earth's magnetic field. Finally, we will be able to correlate these data with our round-the-clock, round-the-world, round-the-year watch on the sun. Increase of altitude is desirable also to obtain greater accuracy of measurements of geodesy, the crustal mass and polar orbits for aurora. It will aid the development of a solar battery and permit simultaneous investigations in related fields (such as aurora and geomagnetism). The satellite will map cloud cover, determine the biological effects of prolonged exposure to radiation, and ascertain the biological effects of weightlessness.

The Middle Area

Surface and interface geophysics includes meteorology, oceanography and glaciology. The observation of the sun, the input of solar radiation, and the output of terrestrial radiation are central to this field of geophysics. It is the sun that evaporates the water from the oceans and drives the atmospheric winds. The huge oceans, which constitute a great thermal bank where heat is stored and withdrawn, exert a tempering effect on world climate. The solar-driven winds act as a ventilator, stirring the ocean surface and driving its currents to distribute this heat. Furthermore, the great ice sheets affect climate by acting as a mirror to incoming sunshine. Ice engenders ice, and melting accelerates melting—one example of the delicate balance in our environment due to reflection of absorption of sunshine. Thus, the whole interaction of the oceans, the land and the atmosphere in surface and interface geophysics is utterly dependent on an understanding of the mechanism of utilization of sunshine. Ultimately this over-all balance involving such things as a global estimate of the albedo of the earth must be aided by rocket and satellite measurements.

The Globe Itself

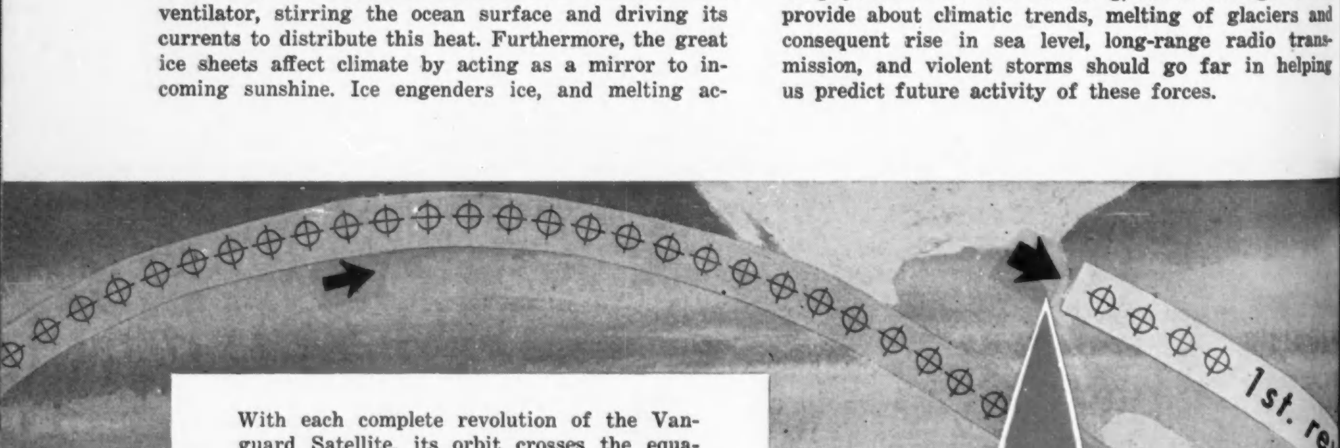
Finally, careful observation of the orbit of the satellite may contribute knowledge about the precise size and shape of the earth. Such observations will give more accurate knowledge of the earth's equatorial radius and its oblateness, and will more accurately link geodetic networks separated by water. Also, local perturbation of the satellite's orbit can tell us about crustal masses.

Watch on the Sun

We have arranged a whole calendar of observations—day by day ones, special world-days for concentrated observations each month, and ten-day world meteorological intervals after equinoxes and solstices. Effects at a time of seasonal change may be of particular interest. We will set up a world-wide warning service to alert magnetic, ionospheric and auroral observers at any time when the sun decides to perform an extraordinary experiment that presages interesting consequences in these other fields. We are providing for quick, special firings of rockets, rockoons or rockairs when the sun's activity causes such unusual events.

The Goal: New Knowledge

What will be some of the practical results of the Geophysical Year? For one thing, the knowledge it will provide about climatic trends, melting of glaciers and consequent rise in sea level, long-range radio transmission, and violent storms should go far in helping us predict future activity of these forces.



With each complete revolution of the Vanguard Satellite, its orbit crosses the equator at a different point. Pictured in green and pointed at the take-off site in Florida is the third stage of the launching vehicle with the satellite shown as a white circle.

Dr. Spilhaus, Dean and Professor, Institute of Technology, University of Minnesota, has written extensively in scientific journals on meteorology and meteorological instruments. He invented the Bathythermograph and is the author of several books. This article is based on an address he delivered before the American Rocket Society.

But even more important will be the answers it will provide to thousands of other questions. Contradictions will arise and questions which we do not yet know enough now to ask—the beginnings of new research. The International Geophysical Year will lay a new groundwork of understanding that may be the basis of global engineering applications for better living in the future.

There are many instances of man, through lack of understanding, exerting a harmful control of his enviroment. One of the interesting programs in IGY is to attempt to establish how fast the ocean can absorb the great quantities of carbon dioxide which the combustion of coal and oil is pouring into the atmosphere at ever-increasing rates—at rates which may double the carbon dioxide content of the atmosphere in a few years. If the adjustment is not quick enough, this will be tantamount to doubling the pane of glass in the atmospheric greenhouse and making it hotter within. By burning these fuels we may unwittingly be embarked on a collossal geophysical control experiment. It is not out of the question that with a far greater understanding of the mechanisms of geophysical processes we should be able better to predict and thereafter possibly be able to exert some planned beneficial control on our global environmental factors, such as the better distribution of natural heat and water.

Renewal of Scientific Interest

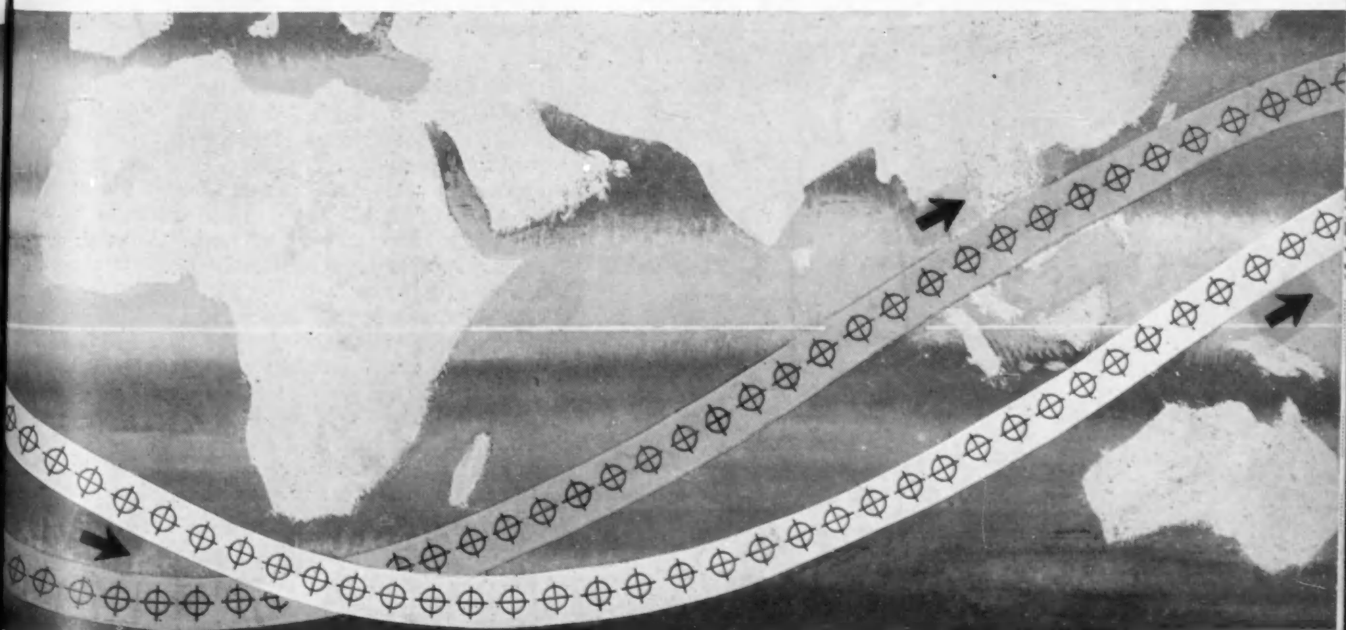
Those of us who have been connected with the planning of the International Geophysical Year have been most gratified at the popular interest in geophysics which it has evoked. A few years ago, if the average lay person had heard of geophysics at all, it was probably as a prospecting method. The Geophysical Year has changed this. Of course, the programs that have captured the public imagination are the exciting ones in Antartica, the use of rockets, and the plan to launch the artificial satellite. Nevertheless, if they can be used to motivate our young anew and to encourage more of them to prepare themselves to participate in these fields of the future, such publicity is all to the good.

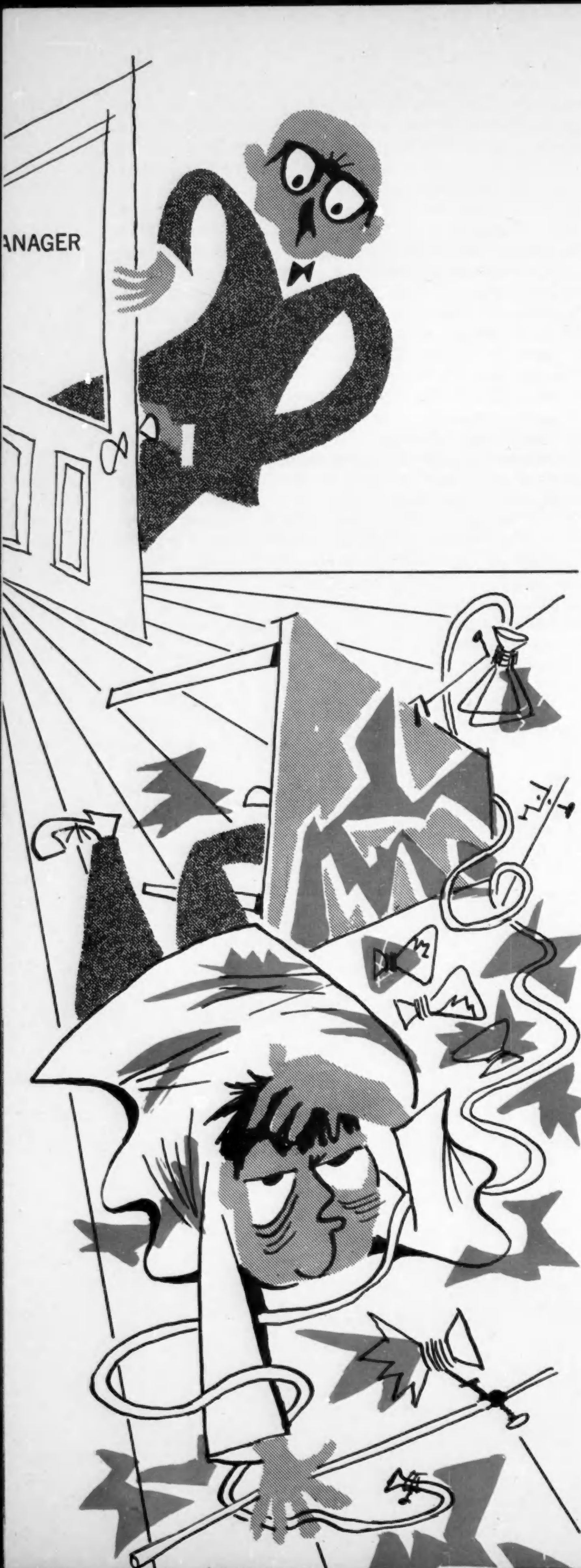
There is no need for me to emphasize how rocketry and astronautics provide a motivation for scholars in many different fields of science, medicine, sociology, law, and almost all other areas of intelligent inquiry.

The trouble with much of our science today is that it becomes so specialized and so erudite that it tends to shut lay people out. By its complexity it tends to discourage young people from entering scientific fields. I don't know whether the Moonwatch program, which will assemble organized groups of amateurs, will really be able to contribute to the knowledge of the orbit of the satellite, but I sincerely hope that it will.

I'm glad to see that articles are beginning to appear in radio magazines which may stimulate radio hams around the world to participate in the satellite program. I read, too, of serious rocket clubs of teen-agers, and I hope that communities will encourage this exciting activity, provide it with the proper safeguards, and not merely ban it as a hazard. I hope, too, that teachers will take a more tolerant and sympathetic view toward the new form of literature which is science fiction. Science fiction in unusual environmental settings, if well done, is educational. In order to find out what is good, it is necessary to let it all emerge and let the distillation of time select that small part of which will be lasting.

Finally, let us hope that this co-operative effort to understand and overcome problems of world-wide scope may be big enough to bind people together in a lasting common interest.





A manager must delegate or cease to grow. How to delegate without inviting risks is a difficult art but well worth learning.

RISKS &

Scott Nicholson

PICTURE THE TECHNICAL MANAGER who has built his function up from a few testing instruments to a department of fifty people. He enjoys a fair research budget, is dedicated to his work, and knows his field so well that he arrives at answers almost instinctively. Yet he can't seem to wring high productivity from his department. This can happen. The most dedicated boss can fail to inspire real effort from his staff if he retains too many functions in his own capable hands.

Many managers who have read manuals telling them they must "learn to delegate" are fairly skeptical about this advice. They suspect that the writers of these manuals have never been responsible for million dollar projects completed against urgent deadlines, or they wouldn't so blithely suggest "letting go of the reins". These executives know that delegation isn't as simple as all that.

Delegation means to entrust to another. And because it involves trust, it carries with it the danger of a trust miscarried. When a manager discovers that matters have gotten completely out of hand, he doesn't care that the mistake was unintentional or that the assignment was unclear, all he knows is that someone "fell down on the job", leaving him exposed and defenseless before his higher-ups.

A Prerequisite of Growth

Yet as difficult as delegation may be, most experienced executives agree that a manager must learn to delegate or cease to grow. His success is measured by the ability to get things done through other people. The manager who will not delegate finds that his people work far below their capacities. He finds himself saddled with details and so busy helping his men do their tasks that he has no time left to concentrate on his own. Finally, by overseeing each detail of his subordinates' duties, he prevents them from growing in their own right.

Technical managers who have made a striking success of delegation generally agree that the answer to the risk of delegating is not in maintaining tight controls but in knowing how to let go. Research directors in several companies, including Chrysler Corporation, General Mills, and Daystrom Corporation have come to believe that many of the dangers of delegating can be avoided. The problem is, of course, one of determining how much to let go and to whom. This is a tall order; but these men say you can get the beginnings of an answer by asking yourself seven leading questions:

REWARDS of Delegating

1. Do You Select Good Men?

Before he died, Andrew Carnegie wrote an epitaph for himself which read: "Here lies a man who knew how to get around him men who were cleverer than himself." Sociologists who have made studies of leadership find that there is one quality almost all leaders hold in common. They all seem to have a knack for surrounding themselves with uncommon men.

We say knack because this ability *is* essentially a knack. It depends on a man's native insight into character. Most leaders select their followers largely on the basis of *rapport*. They seek out those individuals whose minds work on the same wave length as their own. Thus, surrounding oneself with good men requires thinking as good men do. The manager who has the mental equipment to do this is well along the way toward effective delegation. But if he finds himself going from one selection blunder to the next, he is virtually compelled to retain tight controls.

2. Do You Delegate Authority?

A basic maxim of management holds that "authority accompanies responsibility." This is so obvious that it might be presumed to be the way every boss delegates. It's not. Many executives who are liberal in parcelling out responsibility, keep the real authority in their own competent hands. A typical example is the research manager who assigns projects to his group leader but allows the leader no authority over his own men or materials. Both the men and the outside jobbers are aware that for final decisions they must go over the project leader's head to the real boss.

In many cases it's advisable to limit a subordinate's authority. But when this happens the boss should realize that no real delegation has occurred. If a subordinate hasn't received enough authority to do the job, by the very definition of delegation he has not assumed full responsibility. Simply saying that he has doesn't make it so.

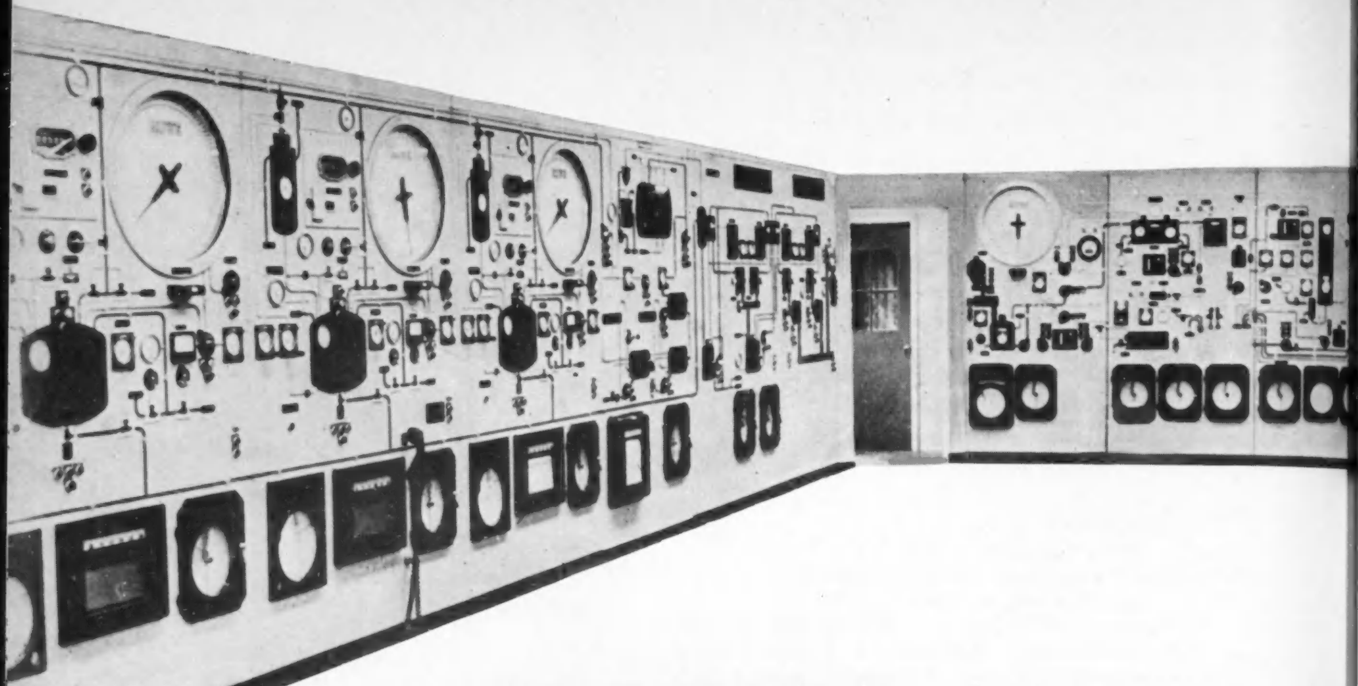
It is here that the question of how much authority to delegate arises. Some subordinates insist that they need wider powers when actually they have all the authority they need to do the job if they would simply approach it properly. But in many other cases the plaint of "no authority" is justified. Many managers who have risen through the ranks have come to realize that striking a working balance between too much authority and too little is the essence of sound delegation. The basic rule of thumb is that authority must match responsibility.

3. Do You Let Your Subordinate Run His Own Show?

Many a technical manager knows his field so well that he solves problems almost instinctively. When he sees a subordinate struggling with a puzzle that he could solve in a twinkling, there is an irresistible temptation to step in and solve it for him. To resist this temptation requires self-control. But in the long run it pays dividends in a staff that's capable of doing its own thinking.

The successful boss lets his subordinates plan their own functions in their own way. He keeps hands off

(Continued on page 34)



CURBING rising costs with Electronic Instruments

READING TODAY'S TECHNICAL LITERATURE, one is impressed by the increasing role of electronics in technology. Electronic devices enjoy such diverse applications as the continuous monitoring of tobacco; automatic grinding of automobile engine blocks; electronically programmed looms to produce unusual patterns in yarn; and the inspection of steel bar and tube at the rolling mill for defects in chemical composition. Other examples include the use of electronics in communication, computation, transportation, and the military. But one of the biggest users of electronic control is the chemical industry.

During the past ten years, cost of labor in the chemical industry has increased 150% and the cost of raw materials has more than doubled, yet the cost of chemical products has risen only 30-40%. To prosper under these conditions requires drastic and continuing reductions in manufacturing costs.

On-the-fly Information

How were these reductions achieved? Essentially, they were gained by replacing small-scale, batch-type operations with large high-speed, continuous processing. In this, electronic instrumentation played a crucial role. One important contribution is that it makes possible split-second quality checks.

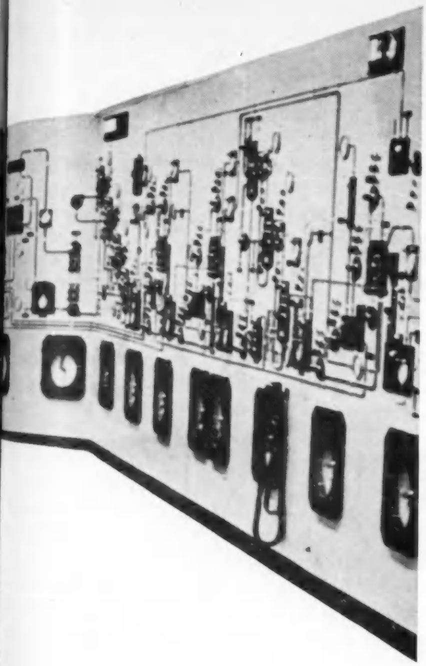
Whereas the batch-type operation permits patient laboratory analyses; the continuous, high speed process requires on-the-fly information. In fact, many processes are so rapid and complex that only fully automatic control can take down and analyze the data. Thus, automatic data instruments have been a very important factor in the chemical industry's ten year revolution.

In addition to process control instrumentation, our people are investigating methods for automatic data processing that offer further cost reductions by tying in the process instruments with computers that are part of the material control and accounting systems. When we learn how to close the feedback loop around the entire plant—i.e., from outgoing product to incoming raw materials—as we are now doing on individual processes within the plant, the visioned push-button plant will be just around the corner.

We do not as yet have the pushbutton plant complete with automatic check-writing and billing facilities. But on the other hand, the industry does have plants where you can walk for miles without seeing an operator.

Heat and Pressure

A second important use of electronic instrumentation in chemical processing is in the delicate business of controlling temperature and pressures. For a number of years we have had instruments for measuring temperature, pressure, flow, and liquid level. But lately—just in the past few years—the sensitivity, range, accuracy, and response speed of these measurements have increased by leaps and bounds. Today, we can buy instruments that



During the last ten years a technical revolution has taken place in the chemical industry—the moving of the control laboratory into the process stream. Behind this revolution is the speed and sensitivity of electronics. Here a du Pont research manager gives examples of special-purpose electronic instruments and describes a unique and sensitive capacitance instrument.

by R. C. McMillen

accurately measure temperatures from near absolute zero to thousands of degrees, pressures from 10^{-10} to 10^{4} atmospheres, and flow rates from a few milliliters per minute to thousands of gallons per hour. In addition to these measurements, instrument manufacturers have made possible the measurement of other process variables, such as viscosity, chemical analysis of gas and liquid streams, chemical composition, color; molecular weight of flowing streams; the thickness of moving webs of films and the amount of coatings applied; the unit weight of moving yarns and filaments; the detection of physical defects in moving yarn and film products; and the molecular orientation in fibers and films.

Variety of New Products

Finally, electronic devices have contributed immeasurably to the product diversification that has made du Pont famous. Fifty years ago, the mainstay of the chemical industry was sulphuric acid. Today the basic product lines of du Pont, for example, number over 1200, ranging from silicon to titanium metal, resins to rubber, dyestuffs to paint, wrapping film to X-ray film, heavy chemicals to textile yarns, and shotgun shells to dynamite. The number and diversity of control and product monitoring problems involved is quite sizable.

Robert C. McMillen is research manager, Applied Physics, Engineering Research Labs., E. I. du Pont de Nemours Co., Inc. Graduated (EE) by Ohio Northern U., he joined du Pont in 1947 as a research engineer, advancing to his present post in 1953. He is a senior member of IRE.

Designing Our Own

While du Pont buys most of its instruments from manufacturers, in many cases it has custom-made its own instruments. We cannot expect instrument makers to develop devices for all of our specialized applications because of the large development costs and the limited markets involved. Also many of our problems require such immediate solutions that there isn't time to order a custom-made instrument outside.

As a result, the du Pont Company and other chemical companies have established research and development groups to provide instruments of this type. Many of the instruments are highly specialized. Each was developed to solve one particular problem. Other instruments, particularly infrared and ultraviolet gas analyzers, find application in hundreds of process stream locations within our company. Designs of some of our more versatile instruments have been made available to instrument manufacturers on a licensing basis and are being used by the industry as a whole.

It is interesting to note that almost all of the tools of electronics are being utilized in process control and prod-

uct inspection. The phototube, photoconductor, and photomultipliers of electro-optical systems play an important part as do the highspeed scanning techniques of TV with their associated gating circuits and wide-band amplifiers. Add to this list pulse circuits, audio and r.-f. generation and detection, magnetic memory, signal delay and amplifying techniques, unusual types of servo, electronic feedback, d.c. and a.c. amplifiers as well as many others.

Reliability of Process Instruments

This broad use of electronics is both a challenge and a headache for the design and maintenance engineer. Until recent years, most of our electronics were developed for the communication and entertainment industries. In these applications, cost was more important than precision. And duration was seldom important. We readily accepted a component life of a few thousand hours.

RESONANT BRIDGE

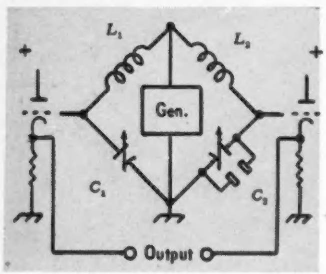


Figure 1

MEASURING CIRCUIT OPERATION

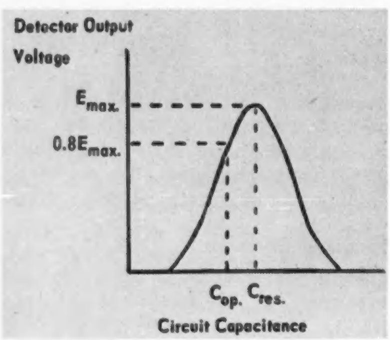


Figure 2

But these factors *are* important in the chemical industry. I know of no industry that relies more heavily on continuous, 24-hour-a-day, 7-day-a-week operation. The cost of instrument failure is reckoned in terms of tens of thousands of dollars incurred by process upsets, not just in the minor cost of repairs. We are always reluctant to install complex electronic control equipment as long as other reliable methods are available. As we place increasing emphasis on electronics, however, the reliability of the instruments must increase through better design procedures and improved circuit components. This rate of improvement must be speeded up if we are to achieve the full potential of electronic control.

Design engineers need to put even more emphasis on reliability. One of the weakest links in vacuum tube circuitry is the vacuum tube itself. With the coming of age of transistors and other semiconductors, as well as magnetic amplifiers, the elimination of the vacuum tube is a worthwhile and attainable goal.

The Capacitometer

Engineers can measure many physical variables by measuring the change in electrical capacitance caused by the movement of one plate with relation to the other plate of a two-plate capacitor. Also, the presence of material having a dielectric constant greater than that of air causes a change in capacitance. We recently developed a simple capacitometer for making these changes, that, to the best of my knowledge, is unique.

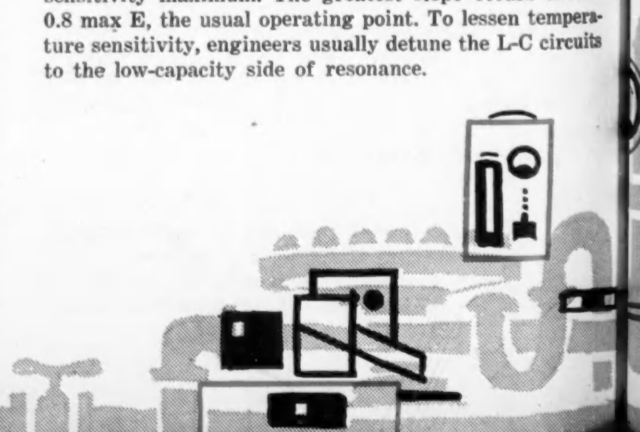
The better capacitometers will have sensitivities in the order of hundreds of volts per micromicrofarad capacitance change. The factors that limit the useful sensitivity of the capacitometers are long-term stability and short-term noise.

Some capacitometers respond to impedance change of a capacitor, but the more sensitive devices are sensitive to frequency shift of an L-C resonant circuit. The engineer attains this shift in several ways. One way is to include the measuring capacitor as part of the frequency-determining elements of a self-excited r.-f. oscillator and detect the frequency shifts by FM (frequency-modulated) discriminators. Conversely, you might place the measuring capacitor in the L-C circuits of the detector fed by a fixed frequency r.-f. generator. To determine capacitance change in other systems, you measure the audio heat note of two heterodyning r.-f. oscillators, varying the frequency of one by the measuring capacitor. All of these methods have certain advantages and disadvantages, but the relative frequency stability of at least two detector circuits is the critical factor common to all methods.

Operating Principle

The basic elements of this capacitometer are a crystal controlled r.-f. generator operating at a frequency of around 30 Mc./sec. and two resonant L-C detectors connected in a bridge configuration (fig. 1). The two tuned circuits that are critical in regard to frequency stability operate in the same type of circuit; that is, as detectors, not as an oscillator and detector. Therefore, we can easily make them electrically and mechanically identical. The proper approach in designing a capacitometer of this type is to reduce to a minimum the frequency drift of the measuring detector and then make the two detectors identical so that they will drift together.

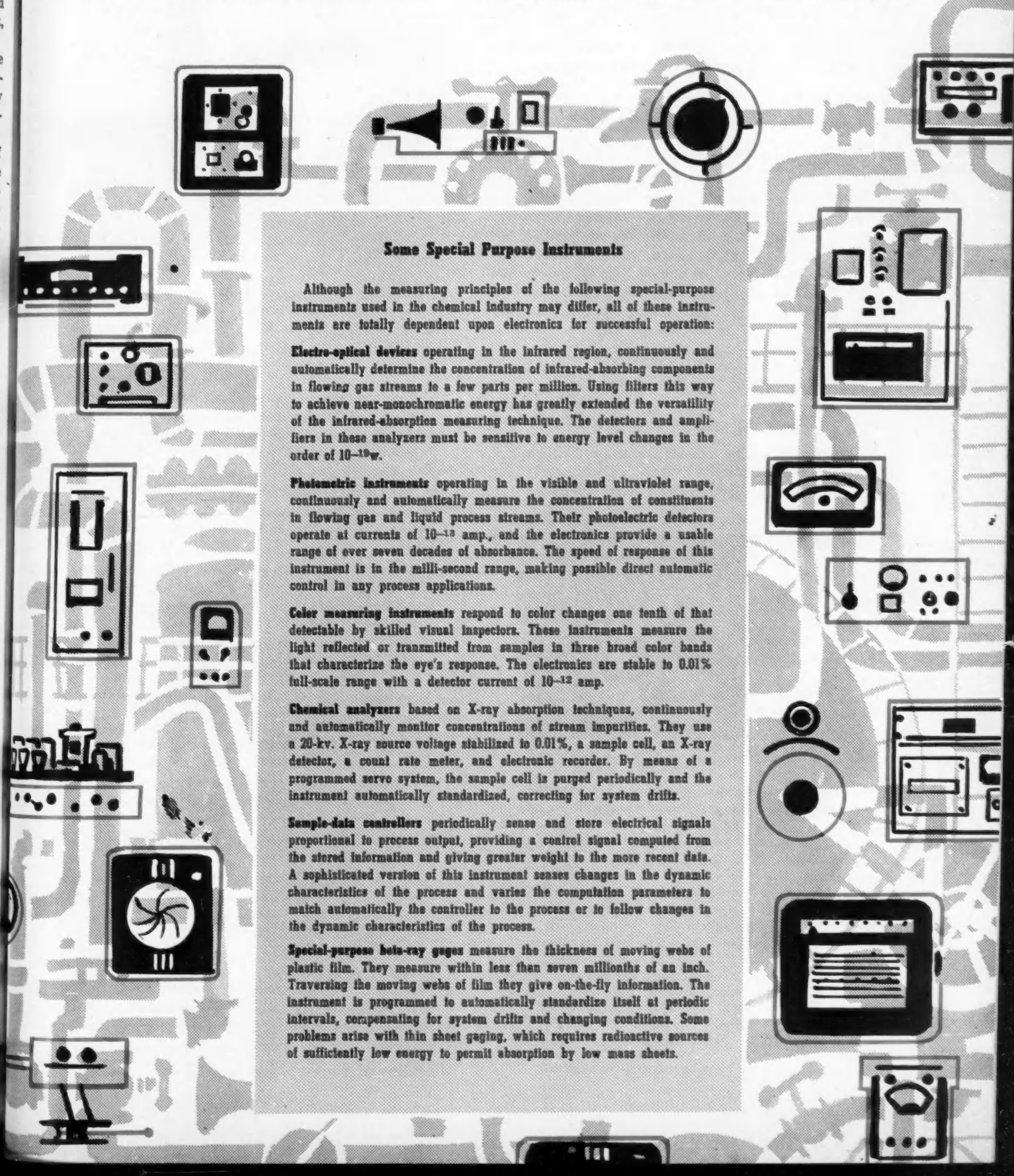
When one resonates the circuit with the generator's frequency (fig. 2) the output voltage is maximum. However, the voltage sensitivity to frequency changes is nearly zero. By increasing or decreasing the capacitance, we can move the operating point off of the maximum of the resonance curve to a point where $\Delta E/\Delta C$, making the sensitivity maximum. The greatest slope occurs around 0.8 max E, the usual operating point. To lessen temperature sensitivity, engineers usually detune the L-C circuits to the low-capacity side of resonance.



Capacitometer Design

Engineers can obtain high sensitivity by using high-Q inductors, detectors that do not materially load the resonant L-C circuits, and by reducing the stray capacity of the L-C circuits to a minimum. They manage to determine the degree of useful sensitivity by the long-term frequency drift of the detectors and the short-term noise generated in the system. Of these, the temperature stability of the detectors is of major importance.

Inductors of printed silver conductors on fused quartz tubes are the most satisfactory. They have a thermal coefficient of inductance of about 1.5 x 10^{-5} µh./°C., that is, an acceptably low error signal. However, the thermal coefficient of inductor resistance is sizeable. It is equivalent to an output signal of 0.1 v./°C. for the best type inductors constructed. Fortunately, the effect of the thermal coefficient of the input capacitance of the tube counterbalances this error signal. It is equiv-



Some Special Purpose Instruments

Although the measuring principles of the following special-purpose instruments used in the chemical industry may differ, all of these instruments are totally dependent upon electronics for successful operation:

Electro-optical devices operating in the infrared region, continuously and automatically determine the concentration of infrared-absorbing components in flowing gas streams to a few parts per million. Using filters this way to achieve near-monochromatic energy has greatly extended the versatility of the infrared-absorption measuring technique. The detectors and amplifiers in these analyzers must be sensitive to energy level changes in the order of 10^{-10}w.

Photometric instruments operating in the visible and ultraviolet range, continuously and automatically measure the concentration of constituents in flowing gas and liquid process streams. Their photoelectric detectors operate at currents of 10^{-13} amp., and the electronics provide a usable range of over seven decades of absorbance. The speed of response of this instrument is in the milli-second range, making possible direct automatic control in any process applications.

Color measuring instruments respond to color changes one tenth of that detectable by skilled visual inspectors. These instruments measure the light reflected or transmitted from samples in three broad color bands that characterize the eye's response. The electronics are stable to 0.01% full-scale range with a detector current of 10^{-12} amp.

Chemical analyzers based on X-ray absorption techniques, continuously and automatically monitor concentrations of stream impurities. They use a 20-kv. X-ray source voltage stabilized to 0.01%, a sample cell, an X-ray detector, a count rate meter, and electronic recorder. By means of a programmed servo system, the sample cell is purged periodically and the instrument automatically standardized, correcting for system drifts.

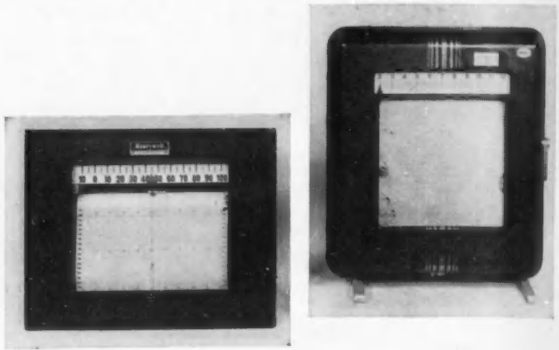
Sample-data controllers periodically sense and store electrical signals proportional to process output, providing a control signal computed from the stored information and giving greater weight to the more recent data. A sophisticated version of this instrument senses changes in the dynamic characteristics of the process and varies the computation parameters to match automatically the controller to the process or to follow changes in the dynamic characteristics of the process.

Special-purpose beta-ray gages measure the thickness of moving webs of plastic film. They measure within less then seven millionths of an inch. Traversing the moving webs of film they give on-the-fly information. The instrument is programmed to automatically standardize itself at periodic intervals, compensating for system drifts and changing conditions. Some problems arise with thin sheet gaging, which requires radioactive sources of sufficiently low energy to permit absorption by low mass sheets.

alent to 0.4 v./°C. if the tube input is connected across the total inductance. Tapping the grid of the tube across only one-half of the inductor decreases this error signal by a factor of four, the impedance reduction being directly proportional to turns ratio squared. This new value of 0.1 v./°C. is equal to the thermal coefficient of inductor resistance and can be made opposite in effect by tuning the detector to the *low* capacitance side of resonance, the normal operating point for the instrument.

Tiny Vacuum Tubes

We chose vacuum tubes as detectors in favor of semiconductor diodes, even though we liked the low shunt capacitance of the latter. Subminiature tubes provide the lowest input capacitance and can be wired directly into the circuit, eliminating socket capacitance and loss. The detector circuit shown is an "infinite impedance" detector, since its grid is never driven positive with respect to its cathode; therefore, grid currents do not flow. This detector provides low loading of the resonant circuits, high d.c. stability, and low output impedance. However, even with this type of detector, the input impedance of the tube at 30 Mc./sec. is about equal to the operating impedance of the resonant L-C circuits. Thus, the effective Q of the L-C circuits and the sensitivity is cut in half. Connecting the grid of the tube to the midpoint of the inductor reduces this loading by a factor of four. Even though this connector reduces the r.-f. voltage by a factor of two, the overall result is a gain in r.-f. voltage developed at the grid of the detector. Furthermore, this connection permits the thermal coefficient effect of the inductor Q and of the input capacitance of the tube to cancel each other.



Sensitivity of electronic recording potentiometers such as the two shown above, has been increased by several orders of magnitude during the past few years. Instruments having a full-scale sensitivity of 50 uv are now available. Special purpose models have a full-scale sensitivity of 0.25 uv with drift and noise level of less than 0.001 uv are now being applied to industrial use.

The zero operating point of the instrument is quite stable since the detectors are bridge connected. However, the sensitivity of the instrument is proportional to the output voltage of the detectors and will vary with changes in r.-f. drive and aging of the detector tubes.

As I mentioned earlier, the circuitry of the capacitometer is not complex, but considerable research and many painstaking evaluations were required to achieve the stability and, hence, the usable sensitivity desired. For example, in seeking the source of drifts and quantitatively evaluating the temperature sensitivity of detector components in terms of 10^{-5} $\mu\mu$f. required some unusual measuring techniques. Our best laboratory instruments were sorely inadequate for precise measurement of these small values.

Summary

During the past ten years, the investment in process control instruments in the chemical industry has risen from less than 2% to 7 to 10% of total plant investment. This trend will continue as long as smaller, high speed process equipment makes possible faster and more accurate control. Electronic instruments, through their speed of response and almost unlimited sensitivity, are playing an increasingly important role in this march towards the automatic plant.

There is no limit to the industrial measurement and control problems that the combination of electronics and other techniques of applied physics can provide. The primary factor regulating the growth of electronics in industry is reliability. With the advent of transistors, greatly improved reliability appears to be in the offing. The opportunities and rewards to the electronic engineer in development, design, and application within the chemical industry are surprisingly large and will continue to grow. END

MATERIALS

Boron Stainless Steel

Used in the atomic energy field in vital reactor shielding and control applications, is a wrought austenic alloy, 1% boron stainless steel. Having thermal neutron absorption qualities many times greater than regular stainless steel, it may also be used in the processing of and disposal of nuclear waste, for storage racks, boxes, etc. The material makes possible important savings in weight and space in various atomic energy components. Superior Steel Corp., Carnegie, Pa.

CIRCLE 30 ON PAGE 48 FOR MORE INFORMATION

Organotin Stabilizer

This all purpose organotin stabilizer is effective with every PVC and copolymer resin now commercially available. Extensive research and field testing reveal that vinyls stabilized with Thermolite 25 possess outstanding optical clarity, do not cross stain and retain brilliant clarity under severe conditions of light, heat and weathering. It is said to be the first organotin stabilizer to be completely efficient in all ratios in the production of rigids, flexible films, plastisols and organosols. Metal & Thermit Corp., Rahway, N.J.

CIRCLE 31 ON PAGE 48 FOR MORE INFORMATION

Gramine-C-14

Gramine-C-14 has been added to the list of radioactive carbon-14 compounds available for purchase under the regular Atomic Energy licensing procedures. This radioactive alkaloid is of value in research in the fields of chemistry, biology and pharmacology. Gramine-C-14 is useful in the preparation of tagged trytophan and in the study of trytophan chemistry and physiology. Available exclusively from Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill.

CIRCLE 32 ON PAGE 48 FOR MORE INFORMATION

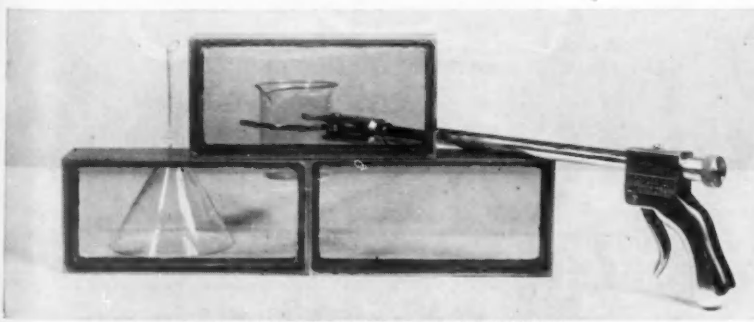
Refractory Cement

A refractory cement has been developed which will hold metal to metal, glass, or ceramics despite temperatures between —420° and 1000°F. Called CA-9, the adhesive is dielectric and highly shock-resistant throughout its temperature range—up to 1500°F. The material remains slightly malleable after drying. Thus it will not crack, craze or check even if used on a constantly flexing surface or to join materials with widely different thermal expansion coefficients. It is waterproof, non-hydroscopic, and unaffected by most reagents. Test specimens have shown no signs of aging after seven months. The new cement was engineered to attach surface-temperature transducers, strain gauges and lead wires to the skins of guided missiles. The transducers are fully encapsulated in the cement, its crack resistance guaranteeing insulation and protection despite severe conditions. A joint of CA-9 between two pieces of metal will resist 80 lb. psi of shear force at room temperature up to 900°F. It is unaffected by 15 minutes of 45G vibration through a one-inch double amplitude at 1500 cycles per second. Wires embedded in the cement are not shorted by submersion in water. The cement is composed of ground phlogopite, a polysiloxane polymer, and refractory oxides. Charles Engelhard, Inc., 850 Passaic Ave., E. Newark, N.J.

CIRCLE 33 ON PAGE 48 FOR MORE INFORMATION

Peephole

A new type of glass shielding brick that is as dense as iron and 2/3 as dense as lead, enables the worker with radioactive materials to perform remote manipulations, observe the action and even read instruments behind the wall shield. The bricks are composed of a special lead glass mixture, and are mounted in a steel frame for protection and handling. The Atomic Center, 489 Fifth Ave., New York 17, N.Y.



CIRCLE 34 ON PAGE 48 FOR MORE INFORMATION

WHAT R & D MEN

an Attitude Survey

by Homer M. Sarasohn

R & D HAS, SINCE WORLD WAR II, emerged as an industry within industries. It has become occupied with newly matured sciences, and peopled with a new class of men. The few men in the vanguard of the physical sciences a few years ago have now multiplied and, under the stimulus of commercial interest and subsidy, have joined hands in America's proliferating R & D departments. Upon the creativeness and productivity of these R & D workers depends the success of R & D lab—the whole R & D effort, and, consequently, the entire future of a company.

Industrial management, by and large, realizes this and has made strenous efforts to adjust to the strange new breed of employees. It has sought, in many cases, to isolate the factors of creativeness, and to provide an atmosphere that would nurture them.

These efforts have sometimes met with a measure of success; more often, in disappointing—and expensive—failure. A 1956 survey reported that the median failure rates for R & D projects in 120 leading companies was 67 percent. The least successful company reported 99 percent failure; the most successful, 50 percent.

How may we account for these discouraging figures? There is no question that the quality of our research people is high; nor is there any question that the quality of our managers and decision-makers is equally high. The answer is probably indicated by the questions: First, are our research people being used most effectively? And, second, are the efforts of management and R &D being coordinated as best they might?

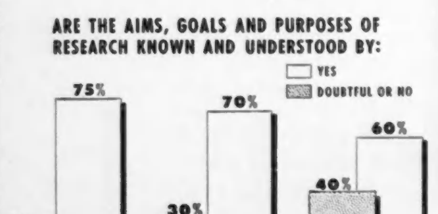
Both these questions have to do with the functioning of people. Consequently, the answers must be largely subjective—how they feel about what they are doing, the way they are doing it, what their attitudes and understanding of their working conditions are. The emphasis here is on *attitude*. It is a well established principle that a man's behavior is determined by what he believes. If he believes the world is flat, he acts as though it were flat. If, regardless of how well a company is managed, he feels that his particular job is not well-organized or well-supervised his job performance will be diminished accordingly.

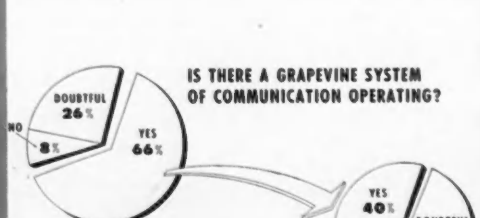
It was to determine these attitudes that the management consultant firm of Booz, Allen, and Hamilton undertook a survey of Professional Research Personnel Opinions and Attitudes, of which this is a preliminary report.

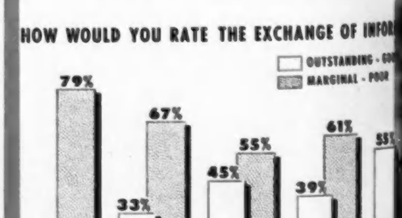
The Problems

A fundamental need in the organizing of a research laboratory is the establishment of an environment which will permit individuals to apply their knowledge and abilities to the fullest extent in the direction of greatest importance to the company. The prevailing notion is that where equipment and facilities are the best that money can buy; where working conditions are relaxed and the

Researchers' Views on Communications







RE SAYING:

hat people think affects what they do. Here E reports what engineers are thinking about pervisors, management and the general effectiveness of the research and development department.

researcher is given head to find his own way; and where salaries meet or exceed competitors' then the success of the lab and the productivity of the researcher must inevitably follow. It may come as a surprise, but these are not the things that preoccupy the man in the lab. When we asked scientists to draw up a list of ten most critical problems, the first three places on their lists, by a wide margin, were taken by managerial matters—communications, planning and coordination, and supervision.

Communications

When we asked 3500 R & D people if they felt that the research division was organized for effective communication, a resounding 59 percent answered *no* or *doubtful*. This put communication into first place on the problem list. The significance is obvious. Until the research man can get proper attention for his ideas from management, and until management understands them, the ideas the researcher is seeking to communicate do not exist. On the other hand, the most productive employee is one who understands his company's aims and recognizes how his job fits into the over-all company objective. Yet, 41 percent of those polled felt that R & D personnel were *not* well acquainted with the strengths and limitations of their company's products; 60 percent were dubious that they were advised of happenings in other departments of the company; and 63 percent answered negatively when asked if they

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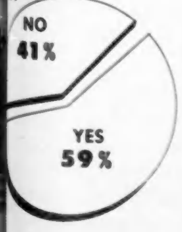
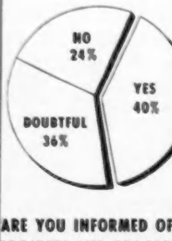
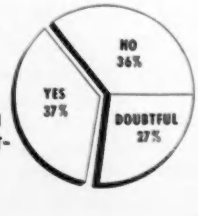


ARE YOU ADVISED OF HAPPENINGS IN COMPANY DEPARTMENTS OTHER THAN RESEARCH?



ARE YOU INFORMED OF RESEARCH PROJECTS AND PROGRESS OF SECTIONS OTHER THAN YOUR OWN?



The TYPICAL R&D Man: A Statistical Portrait

He's an engineer, about 34. He's been in R&D for 1 to 5 years, has a B.S. or equivalent, and earns about $7 thousand a year. He feels that management looks upon R&D as indispensable, but he tends to identify himself more with his profession than with his company. He is sensitive to professional recognition—and very sensitive to the lack of it. Much more than his non-technical counterpart, he is convinced of the necessity for continuous training and education in his specialty in order to keep up with technological change.

He finds his work challenging—most of the time, and is confident of his ability to meet its demands. By and large, he thinks his top research executive, with regard to scientific and administrative ability and leadership, is good—and more often outstanding than marginal or poor. His immediate superior stacks-up only a little less well.

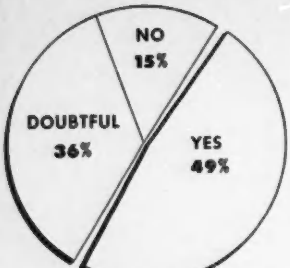
He doesn't feel that he has enough voice in the selection of projects; he feels a little better about how much he has to say about the conduct of research; and much better about his say in the design of experiments. He's somewhat ambivalent about company policy in terms of personal recognition and reward. He thinks that the factors influencing promotion in his lab take this precedence: research ability; getting along with others; supervisory ability; influence and politics; papers, patents, and professional recognition; and, finally, administrative ability. But more than any single one of these, he feels that a logical combination of all is most influential.

He rates his advancement opportunity in his present company as marginal to good, and would prefer the professional line of advancement to the administrative, though he has an inflated idea about opportunities in the latter. By and large, he feels that he could be promoted anytime within the next year. He's not clear on whether he would eventually prefer promotion or transfer outside the research division, but he's fairly sure that he wants to make a career of research.

Though his firm does much research work for the government, he thinks that the continued prosperity of his company depends more on general business conditions than on government activity. He doesn't feel that his job is much more secure than other jobs generally. In the event of a downturn in company business he thinks the resultant cutback would effect the research lab about the same as other company operations.

Generally, he would rate his company as a better place to work than others, though he has some reservations.

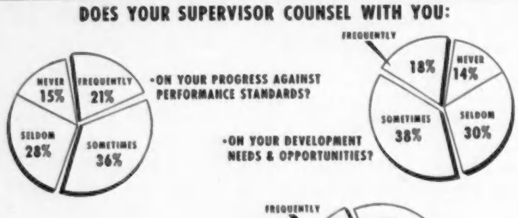
Supervision and Incentives

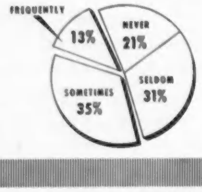


DO YOU KNOW THE PERFORMANCE STANDARDS EXPECTED OF YOU?

IN YOUR PRESENT POSITION DO YOU HAVE AN OPPORTUNITY TO DO THE WORK FOR WHICH YOU ARE BEST QUALIFIED?

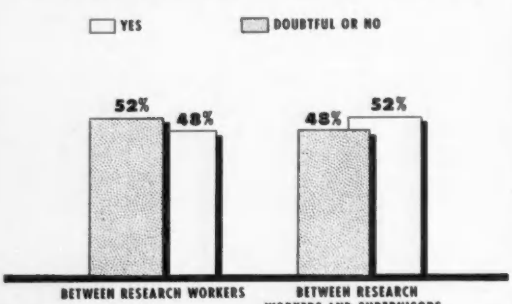
DOES YOUR SUPERVISOR COUNSEL WITH YOU:



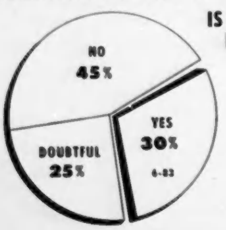


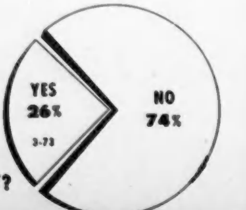
DO YOU RECEIVE ON-THE-JOB INSTRUCTION FROM YOUR SUPERVISOR?

ARE WORKING RELATIONSHIPS CLEARLY DEFINED?



IS THERE A WRITTEN DESCRIPTION OF YOUR JOB?





DO YOU HAVE A COPY?

were informed of research projects and progress in other sections than their own. The over-all communications picture is summed up by a whopping 64 percent (averaging the percentages for all inter-departmental relations) who would rate the general exchange of information as marginal to poor, and 32 percent who thought that the aims and purposes of research were not understood by research management, top management, or research personnel.

Planning and Coordination

Vital to the success of new product development—and hence, of the activities of the R & D lab—is close cooperation between R &D and the Sales and Manufacturing departments. Yet, these two departments were rated lowest by researchers in terms of cooperation with the research activity. 38 percent rated them marginal or poor. This points, if to nothing else, to a lack of integration of the research activity with the other branches of the company. Little wonder that 67 percent of research projects end in failure.

Lack of coordination and planning is exemplified in other ways too. Forty-seven percent of R & D people feel that their research division is *not* well organized for effective research. This poor integration and lack of planning has many side-effects. More than two-thirds of the researchers questioned observed that there were service functions and trouble-shooting duties they had to perform in addition to their main research activities. Fifty-six percent found that these side duties disrupted the progress of their research in varying degrees.

Were planning and coordination improved, both these deficiencies might be corrected and an appreciable increase of effective skilled man-hours could be realized.

Supervision

Supervision is fundamental to the success of an R & D lab. It is also a major problem. It is the link between policy and planning, on the one hand, and the realization of the plans, on the other. Yet, in so fundamental an area as the researcher knowing what performance standards are expected of him, more than a third were not sure. In terms of years of experience, those with 20 years or more were still 36 percent not sure; and those with one to five years' experience, a catastrophic 60 percent were not sure what was expected of them.

Many elements contribute to this expensive ignorance. Here are a few: Written job descriptions exist for only 30 percent of the sampling; of those whose job is so covered, only 26 percent have copies. 52 percent do not work under clearly defined relationships with other research workers. 48 percent do not work under clearly defined relationships with their supervisors. What more important function has the supervisor than to counsel with his subordinates about their progress against performance standards? Yet, 43 percent are seldom or never counseled, and only 36 percent *sometimes* are.

These are some of the elements that contribute to poor supervision. It is clear that here too communication is a contributing factor.

Other Problems

Besides providing a barometer of opinions and attitudes of R & D personnel, the survey provides a means of measuring the impact of management on the company, and indicates, too, the areas in which further thought is needed. Training and development, a management challenge in all divisions of the business, appears

Homer M. Sarasohn has been, since 1950, an associate of Booz, Allen & Hamilton, management consultants. He has helped set up R & D departments for many large companies. His consulting experience also covers radio and electronics engineering, laboratory and plant layout, production equipment and process improvement, and quality control. He has conducted engineering facilities studies for the Bureau of Aeronautics and the Voice of America.

to be a particularly acute problem in R & D. This stems from the relative youth of employees in R & D, the comparative business inexperience, the rapid growth of the R & D function in recent years, and, finally, from the shortage of scientists and engineers.

In matters of salary, the R & D man is pretty generally satisfied. He is apparently more concerned with problems of professional status and development. To support this notion are the 47 percent of respondents who feel that their professional recognition was marginal or altogether lacking; and the 34 percent who feel that they do not receive proper credit for their ideas and accomplishments.

To Sum Up

An enormous amount of material about attitudes was uncovered by the survey. Some will take months to digest. In this preliminary report, we have sought to present the most salient areas of concern, and thus indicate what needs most immediate attention.

In general, it seems obvious that the successful techniques of business management have not been fully developed or applied in the research area. For this there are at least five contributing factors:

1. Scientist-managers are not familiar with these management techniques, probably because they are new to business.

2. The newness and rapid growth of large scale R & D has provided little time for the evolution of successful management techniques.

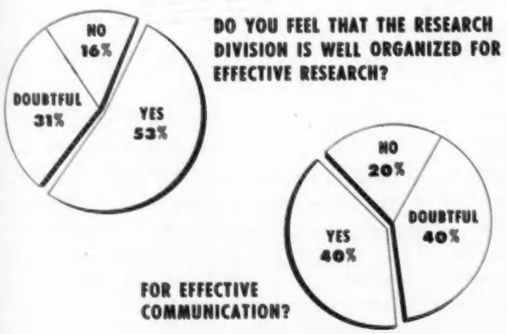
3. The capacities and limitations of research are not clearly delineated.

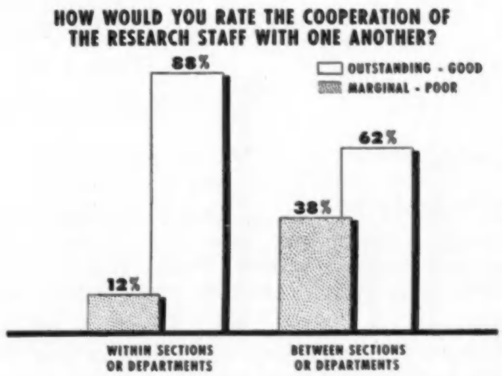
4. Widely prevalent is the notion that were management techniques applied to this area, genius and creativity might be frustrated.

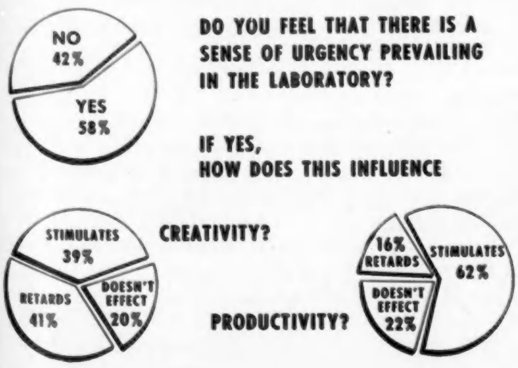
5. The objectives and goals for research require further definition and clarification.

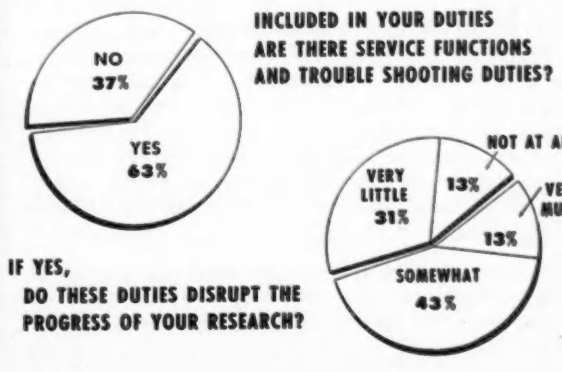
One conclusion from the results of the survey arises inescapably. More active management of R & D is a must. The unstructured *laissez faire* situation is conducive to the poorest research performance and the lowest productivity. The research activity ***must be brought into the business.*** Researchers do not abhor good management—they want it, and need it. END

Coordination of Research Efforts









Photographs by Lawrence Sandek

TO FACE FACE

R/E interviews DR. EMMANUEL PIORE
Director of Research INTERNATIONAL BUSINESS MACHINES

on Short-Range vs Long-Range Research
What IBM Expects from Research
The Effect of Government Spending
Problems in Getting Skilled Manpower

QUESTION: To most of our readers the name IBM is synonymous with computers, tabulators, bookkeeping machines and related equipment. Would you give us your thinking on the present status and future of these units?

ANSWER: Certainly. We might start with this consideration: There are two main problems that have always worried the human race. One is the energy requirement and the other is the food problem. Uranium fuel has essentially solved the energy requirement. Food? I don't know.

Now we still have a problem of utilizing the energy and having it flow in proper directions—controlling it. That is what business machines do. You take any industrial setup. Its expansion possibilities will be blocked unless it solves the manpower requirements, or in some way mechanizes. For example, if the telephone company hadn't installed the dial system, the country's present telephone requirements would commandeer every woman between the ages of 20 and 40.

There has been a lot of discussion about the problem of keeping research teams producing or creating. What can be done when they hit a slow area—when they aren't producing?

Well, a lot depends upon what you're producing. Engineering outfits have to produce certain things. If you're designing a machine you've got to get the machine out. You have a factory schedule and the sales people have backlogs. So that's easy. But when it comes to science, knowing your objective is much more difficult. No one has the answers.

All this business about teamwork as against individual research can be sheer nonsense. Some areas obviously require teamwork. Others don't. This is an old problem in science. There has always been teamwork in astronomy, simply because the instruments are expensive. There has always been teamwork in organic chemistry.

Now, when it comes to creative scientific people, you first must have a community of scholars with some kind of interest. The scholars have to be bright people. And then just leave them alone. If you start mixing in —pulling this guy out, putting another guy in, trying to make a better team, you're going to run into trouble. And the reason you run into trouble is that it takes a number of years to get a team working together. People make the mistake of thinking in terms of baseball—

(Continued on page 32)

CIRCLE 13 ON PAGE 48 FOR MORE INFORMATION

FACE TO FACE

(Cont. from p. 30)

one poor inning and you change the batting order. Well, in research it isn't quite so. Let me put it this way. IBM is going into, say, low temperature research in the hope that it will derive some kind of insight into where this fits in the computing situation. I don't expect that we'll get any significant results out of this for three years. This is the gamble we've made, and that's that.

Then you just leave them alone?

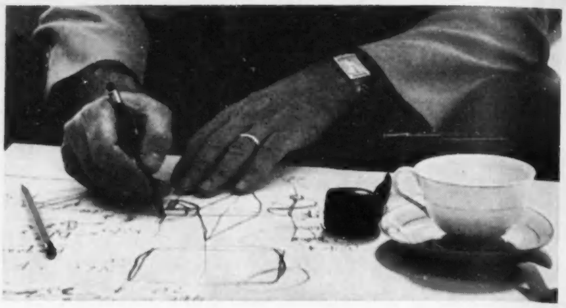
Well sure. If you see the fellows aren't doing well, you mix in. But you don't keep shaking it up every three months. Now the situation you have to watch very carefully is when it comes to getting a transistor into product development where you're trying to make sure that the next machine (say in two years) will have effective transistors. In engineering, which is close to production, you may have to bring in new people, change the composition of the team and so forth. You have to intervene quickly at times. In research on the other hand you have to have the wisdom to leave things alone.

Working on advanced computers apparently leads into various avenues of research.

Yes. In connection with computers, we need some economic research. We also ought to have some biological research.

Why biological?

We're interested in the physiology of the nervous system of the brain. We may develop some very interesting insights which may have an impact on information



theory and computer design. That's where our interest in biology comes in.

Could you now talk about the place of government in the industrial research picture?

Yes. Let's face this fact, of the total money spent for research and development on a national scale, a tremendous portion of it is government money. Let me put it another way. We have gross national product of \$400 billion and the budget is \$70 billion, so that the Federal Budget is about 1/5 or 1/6 of our economy. On research and development the total is say \$6 billion and the Federal Government most likely gives \$3 billion or \$2.5 billion. So as far as the technological budget goes the Federal Government pays close to half of the cost.

It does more than that. The technological demands of the Dept. of Defense and AEC propel in a sense, the rest of us ahead. When the Government builds a reactor or when it tries to operate engines at 2000°F., it certainly is putting a terrific strain on the nation's knowledge of metallurgy. The Government is doing more to stimulate us technologically than any single industry; whenever labs are being forced to move rapidly technologically, you'll find that some kind of Government project is involved.

Does this influence have a tendency to broaden the area in which industry operates?

Yes, it broadens the area and also accelerates our progress. The rate of our technological progress depends tremendously on government money and the requirements the government sets forth. You take something like the titanium industry. It never would have left the ground without government backing. The same is true of computers. After the War the digital computer field was spurred on by government funds. People hate to admit this. And except for IBM, every company that's gone into computers has received money from the government.

Are you as concerned about the lag in science education as other educators and technical managers seem to be?

Our whole technological future depends on the output of engineers and physicists from our schools, especially from the graduate schools. I look for Ph.D's as the principal source of scientific manpower. And just as our medical schools cannot produce more M.D's because facilities are limited, graduate schools can't turn out enough physicists.

With increases in capital investments, someone has to move in with money to build facilities. The Federal Government may have to assist. You take New York state; colleges are being built right and left but they're all undergraduate or junior colleges. We must give immediate attention to the needs at the graduate level.

Private donations will help, of course, but the main stimulus may have to come from the public revenues.

Americans are in a peculiar state of mind, you know, emotionally and economically in regard to all this. This has nothing to do with private enterprise or political philosophy. What is important is strengthening our graduate schools—increasing them in scope, giving them more equipment; and this has to be done throughout the country. We must let the Federal Government—either through the departments or the National Science Foundation—somehow siphon that money in there. I have no strong feelings of how this is to be done. But it has to be done.

Will you tell us about IBM's methods and success in getting top physicists and other scientists? Have you suffered from any shortage in technical manpower?

Good companies can get the people they're after. Let me put it this way. I know Bell Telephone Labs draws from the cream of the crop; that is, on the graduate level. We do too. Now in order to do it requires a great deal of work; you might have to interview five top people to get two. But we get the top people.

Very bright people normally choose jobs in this order: academic first; industrial second; and governmental third. Our problem is to get the top people who want to go into industry. Also, to convince some top people who want academic jobs to come with us. If we work hard at it, we get our quota of good people.

What is IBM's position in regard to government contracts? To what extent are you involved in work for the military or other governmental agencies?

In research we will undertake a government contract only if it fits into our planned program, and we'll use the government money to accelerate that program. We will not go soliciting for governmnt funds to do research that the government wants done. We have a rule that we won't permit more than about 10 percent of our income in research to come from the government. Otherwise, we would not have an IBM program, but some conglomoration reflecting the needs of various governmental departments. We feel that we're most useful to the community if we have our own program. We're useful in the national economy because we're in a certain kind of business with a research program that supports that business.

What percentage of your research budget is supported by government money?

I think at the moment, in over-all research, the government funds are about 10 percent of our activity and that's about as much as we'll ever accept. Now as research grows, we'll permit more government money to flow in, but the percentage is not going to change.

As a final area of inquiry, Dr. Piore, do you feel that there's a general trend of American industry to have technical people more and more on the top level of management, and will this trend continue?

Pretty definitely. I think you'll find that Wilson—all the Wilsons—both of Indiana and General Motors, are all of engineering training. Sloan, although he came up from General Motors sales, is an M.I.T. graduate of an engineering course. Big companies like A.T. & T. have been putting technical people on their boards of directors.

Thank you, Dr. Piore.

while the subordinate goes through what may even be the wrong steps, because he recognizes that learning does not take place in an artificial, protected climate.

The manager who requires that the details of every job conform to his own working preferences will have his men calling upon him every minute for advice, and the work in the department will slow down to a snail's pace. But the boss who lets his subordinates plan their work in their own way will find his men growing in confidence and taking an increasing amount of the load off his shoulders.

4. Do You Have A Yardstick of A Job Well Done?

If you don't, perhaps you should, as much for your own sake as for that of your subordinates. Setting up criteria of what constitutes a successful performance of the job gives your men a clear measure of achievement. Also because it commits you to a firm standard in judging their work, it brings rewards in high morale in the department.

In setting up performance standards, the fairest way is to measure the job by the end product. Many managers like to include a number of subjective quantities in their merit ratings—quantities such as human relations ability, cooperativeness, and loyalty. As important as these abilities may be, successful managers agree that these criteria are too ambiguous, too subject to distortion and prejudice, for fairly judging the subordinate's work. For this reason the best and fairest standards are those based on end product: on, for example, the number of patents produced, or the number of projects finished on deadline.

Establishing a yardstick of a job well done is difficult. For one reason, breaking down a job into measurable factors is a laborious process. It may force the manager to a much deeper re-assessment of the work in his department. Equally as important, by going on record as to what constitutes a job well done, a manager surrenders one of his favorite prerogatives—the right to shift ground rules on his men.

But usually it's worth it. Letting the subordinate know beforehand what constitutes a good job inspires self-confidence and security, and lays the foundation for genuine, sincere recognition of work well done.

5. Do You Keep Checking-Back to A Minimum?

Whenever a job is delegated there is an obligation to keep the boss informed. But if work is to move ahead on schedule, the subordinate cannot always be going back to touch home base. The very process of reporting is extremely time consuming. If a manager follows the policy of constant checks he may find himself mired in conferences, paper work and detail. The resolution of this problem is very simple. The rule involves two points:

(Cont. on page 36)

Delegation Defined

DELEGATION—Investing another with authority to act in your behalf. Because it is based on the transfer of authority, the extent of delegation that has taken place depends on the amount of authority that has been passed along.

RESPONSIBILITY—Being charged with results for the administration of another's affairs. Responsibility cannot be transferred. Thus, investing a person with responsibility for the success of an operation does not mean that you divest yourself of liability for the operation. The principal remains fully responsible to his superiors for his subordinate's actions.

AUTHORITY—A power or right to act excercised by virtue of one's office or jurisdiction. Authority is lent in trust. Because it is only lent, the principal cannot withdraw it at will.

ACCOUNTABILITY—Liability to answer to your principal for the conduct of his affairs. The subordinate is always subject to giving a full accounting of his activities at all times.

Engineers have seen too many debacles result from the "Yours is not to reason why" attitude to be overly impressed.

Delegating

(Cont. from p. 34)

1. The subordinate should report those things which are either especially significant or at variance with routine.
2. He should be allowed to do the job on his own initiative until he has the complete package to present.

The manager who follows these two rules will find his men growing in competence and self-assurance. Failure to follow them will keep both the manager and the subordinates hamstrung with communications problems.

6. Do You Define the Job's Objectives?

In research and development, where so much of the work is secret or classified, it is easy for the manager to adopt the policy of saying "Do it, and never mind why." Too often this attitude carries over into matters that are not secret, but simply involve questions that are difficult to answer.

Turning away a subordinate's request for more information is a common practice in many companies. The idea that there are certain secrets that only top men are privy to leaves the boss with a very warm and satisfying feeling of omniscience but it does not satisfy the subordinate.

The attitude of "Yours is not to reason why" went out of fashion with the Charge of the Light Brigade. Usually only the manager himself is deceived by this tactic. Engineers have seen too many top brass blunders cloaked by this attitude to take the explanation too seriously.

The manager who comes right out with clear explanations of the ultimate purpose of an assignment will find that he gains respect and cooperation from his subordinates. Forcing them to do a job without knowing the reason or ultimate objectives invites errors, misunderstanding, and resentment.

7. Do You Encourage Subordinates to Anticipate Needs?

Doing so will pay dividends in a more alert staff. Also you may gain some good suggestions in the bargain. Getting the subordinate to think about his field of responsibility as his own, alerts him to thinking critically about every aspect of his assignment and its relationship to the over-all work in the company. This approach is the basis of executive development programs in many forward-looking companies.

However, because anticipating needs involves planning, which is the essence of the management function, it is difficult for many managers to let others in on this activity. They feel that planning is a manager's exclusive prerogative and should not be surrendered to people further down the line. However, progressive companies have found that the further down the line that you delegate the planning function, the higher will be the rewards in ideas, suggestions and loyalty.

A General Approach

This brings us back to where we started. The process of delegating isn't easy. It involves risk and it requires patience. But if a manager possesses the native skill of selecting competent men, and the self-restraint to allow them a free hand, he will find himself at the head of a surprisingly dedicated group of engineers.

Freeing SCIENCE SKILLS

The spectrophotometer is used extensively for vitamin assay work. Tests that formerly took 24 to 72 hours are now completed in minutes, with this tool which analyzes the light spectrum for quick identification of substances.

AMERICAN TECHNOLOGY IS GROWING by about 12 percent a year. The supply of skilled personnel that each year becomes available is startlingly below that figure. But the gap is being bridged, at least in part, by modern scientific laboratory instruments.

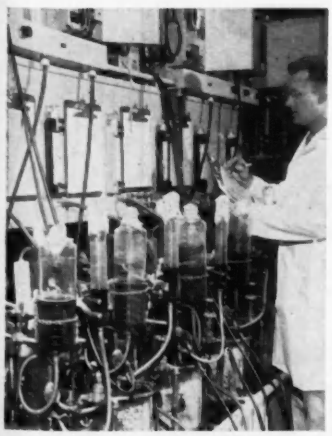
Among the scientist-managers who daily have to grapple with the shortage is Dr. J. Peter Kass, director of research for the Pabst Brewing Company. Noting the difficulty of finding adequate numbers of scientists for his own operation, Dr. Kass points to a spectrophotometer; "With that machine alone, we've been able to free some of our high-level brains for an additional 200 hours a week of non-routine, creative work. In effect, it represents 5 PhDs."

Add to these "5 PhDs", the additional time saved in processing operations—in the order of two thirds for the quality-checking refractometer alone—and multiply the result by the variegated activities of Pabst and the total time saved mounts into man-years.

Besides being a major producer of canned soft drinks, Pabst, through its Industrial Products Division, is a major source of several rare enzymes, antibiotics, and bio-chemicals. They also manufacture and market animal feed supplements; and products for the textile, dry cleaning, and other industries.

In all this diversified activity, man-saving hour-saving instruments are invaluable factors. Researcher Kass sums up, ". . these instruments are making up for the highly trained people we don't have—and can't get".

Formerly added by hand, anti-foaming agents are now added automatically in this laboratory operation which saves hundreds of hours each year. Freed from such routine tasks, scientists can now devote their technical background to more creative work.



Alcohol distillations in Pabst's quality control laboratories used to be time-consuming, tedious operations. Here, another tool of science, the refractometer does the job and saves more than two-thirds of the precious hours formerly taken for the quality check.

YARDSTICKS

Electrolytic Hygrometer

Operating in the difficult 0— 1000 ppm range in temperatures up to 100° C, a panel mounted electrolytic hygrometer automatically and continuously measures water concentrations in vapor samples with 5% accuracy. Analysis is performed by continuously passing a sample gas stream through a special analytical element that absorbs and electrolyzes all moisture present in the stream. The current required for this electrolysis is a precise measurement of the amount of water present. An alarm system that can be set for any point in the hygrometer's range is incorporated in the unit. A standard 10 or 50 millivolt potentiometric recorder or recorder-controller can be operated from the instrument's output for continuous monitoring of water in a process stream. Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

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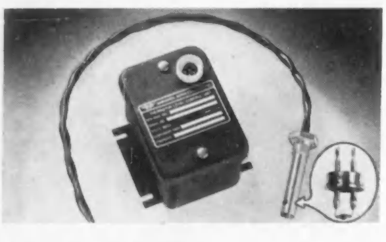

Liquid Level Indicator

Reliable, accurate and trouble free indication of liquid level is provided in this liquid level sensing system. The device is capable of operating a light to indicate whether or not liquid is above or below a certain level. It can also actuate a control to start or stop pumps, or can operate valves to transfer liquid from one tank to another. It has no moving parts, and is resistant to shock, vibration and corrosion. A-c or d-c powered, with low power consumption, the Simmonds Liquid Level Sensing System operates in any military aircraft fuel, hydraulic fluid, aircraft gas turbine lubricating oil or other hydrocarbon liquids. It can be designed also for many liquefied gases. The unit operates in liquids from 75° C to —55° C or their pour points, whichever is higher. Simmonds Aerocessories, Inc., 105 White Plains Rd., Tarrytown, N. Y.

CIRCLE 41 ON PAGE 48 FOR MORE INFORMATION

Infrared Monochromator

Radiations from other aircraft and missiles can be observed on an airborne infrared monochromator when installed in a bomber. A complete radiation laboratory in itself, the AIM is designed to determine the absolute spectral distribution of radiation from airborne targets in the 1.5-25 micron region, to determine the total radiation from targets and to record these measurements on a two-channel recorder. The device is also a valuable research tool for finding aircraft designs that are least susceptible to detection by enemy infrared instruments. Servo Corp. of America, 20-20 Jericho Tpk., New Hyde Park, N.Y.

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Mass Spectrometer

Problems of analyzing extremely small amounts of gaseous mixtures, or liquids capable of being vaporized, can be solved with an inexpensive, portable mass spectrometer. Precise batch or process analyses can be performed in the field or in the plant. The over-all mass range of the Type 21-611 Mass Spectrometer is from 2 to 80 with resolving power adequate for separation of adjacent peaks up to about mass 35. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

CIRCLE 43 ON PAGE 48 FOR MORE INFORMATION

Light Change Detector

A photoelectric instrument designed to detect light changes in the micro-lumen range, the operating sensitivity of this unit is adjustable within a wide range of light change limits to meet specific requirements. The device is designed to detect deviations from normal configuration of solids, liquid and visible gases passed before the eye of the unit. The instrument has found successful application in the textile industry in detecting flaws, counting and maintaining quality control in yarn production. Variations in wire, vapor, webs or filaments of any material may be automatically detected, counted, and if desired, a stop motion actuated. Lindly & Co., Mineola, N.Y.

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Bridge Balance Unit

Designed to embody the advanced instrumentation technique of Series Calibration and eliminate the need for data reduction personnel to average-through calibration pulses or fair zero and base line references, this automatic-calibrating bridge balance unit is useful in missile range instrumentation systems and in flight test programs of advanced military aircraft. A time and effort saver for balance, control and series calibration of strain gages, accelerometers, pressure pickups and other resistive type transducers, the Model 24-202 is of special value in recording dithering type information and provides calibration steps that are truly square wave for clearer interpretation. The unit provides independent adjustment for each channel of voltage, balance, galvanometer damping, sensitivity, calibrating level and phase. B & F Instruments, Inc., 4732 N. Broad St., Philadelphia 41, Pa.

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Quartz Crystal Goniometer

Even unskilled operators can orientate crystal surface and lattice planes quickly to accuracy within 30 seconds of arc, with a high precision quartz crystal x-ray goniometer imported from England. The instrument features a large, direct reading scale, simple controls, and a higher sensitivity than required for even weakest quartz reflection. It is suitable for routine testing of both large and small crystal blanks and may be used with either a high intensity microfocus x-ray unit or with conventional x-ray diffraction equipment. The Hilger Model Y-130 Goniometer is available from Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

CIRCLE 46 ON PAGE 48 FOR MORE INFORMATION

Plug-in Building Blocks

These transistorized logical circuits for asynchronous digital computing, data handling, logical analysis, simulation, and control systems, are designed for d-c operation in the zero to 100 kc range. Basic circuitry is derived from the Eccles-Jordan flip-flop and the multi-leg diode gate. Transistorized M-PACs offer advantages over vacuum tube circuits in reduced size, low power requirements, low operating temperature and increased reliability. They can be combined to perform all digital operations including arithmetical computation, storage, programming and logical decision. Operations are determined by the manner in which the different basic packages are connected. Complete systems can be built up with the units by interconnecting terminals according to simple guide rules. Systems can be designed, constructed, maintained and operated from simplified block diagrams which give basic system logic, M-PAC locations and pin-connections. There is no need for circuit design and component selection except as required for auxiliary data input and readout stages. These systems may be powered by standard transistor supplies and are compatible with commercially available storage and readout devices. Although designed for asynchronous applications, the units may be used in synchronous systems with appropriate clocking circuits. For efficient and rapid system implementation, the M-PAC line includes the following basic packages: Flip Flops, Emitter Followers, Pulse Amplifiers, Diode Gates and Buffers, Inverter Amplifiers, One-Shot Multivibrators, Variable-Frequency Blocking Oscillators, and Crystal-Controlled Square-Wave Oscillators. In the case of Pulse-Amplifiers, Emitter Followers, Gates and Buffers, each M-PAC contains two complete circuits. All are designed for high reliability and stability and are completely compatible with one another in all normal combinations. Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.

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COMPONENTS

Oscillator in ¾-Inch Cube

Encapsulated in a ¾" molded epoxy cube, this complete blocking oscillator circuit includes a subminiature pulse transformer, transistor, capacitor, resistor and crystal diode. Available either as a free-running blocking oscillator or as an externally triggered type, the Pulse-Cube can be furnished as a plug-in or as a solder lug type. The operating temperature range is from —55°C to 60°C. Allen B. DuMont Labs., Clifton, N. J.

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Thimble-Size Rectifiers

Designed for a maximum output of 600 milli-amperes at a case temperature of 150°C, these stud-mounted selenium rectifiers are capable of withstanding a maximum one-cycle surge current of 15 amperes, and will operate to 170°C. General Electric, Semiconductor Products Div., Syracuse, N. Y.

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Midget Sequence Relays

Inexpensive midget sequence relays with a variety of DP-ST abd DP-DT contact arrangements are useful where a predetermined cycle of operation is needed. A unique double cam movement permits contacts to be adjusted to operate when the coil is *de*-energized. The ability to transfer contacts on either the "operate" or "release" phase offers sequence arrangements never before practical in a simple inexpensive unit. Molded spacers lock the contacts into position and provide 150-volt insulation to meet U. L. requirements. Contact spaces and pushers are of moisture resistant phenolic. Ratchets and cams are Nylon. Struthers-Dunn, Inc., Pitman, N. J.

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Miniscule Transformers

This complete line of transformers for transistor applications consists of 32 items comprising two series: a 150 milliwatt series 21/32" H x 12/16" W x ⅝" D with mounting tab centers 13/16", and weighing 0.6 ounces. A 300 milliwatt series is 13/16" H x 1⅝" W x 13/16" D with mounting centers 1⅜". The weight is 1.1 ounces. Gramer Halldorson Corp., 2734 N. Pulaski Rd., Chicago 39, Ill.

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Smallest Insulated Terminals

Dispensing with threads, nuts, washers, lockwashers and seals, by taking full advantage of Teflon insulation and press-fitted installation, these smallest insulated terminals are claimed to be the smallest yet available. Dimensions of the units are 50% less for overall diameters and lengths than terminals calling for mounting hardware. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N. Y.

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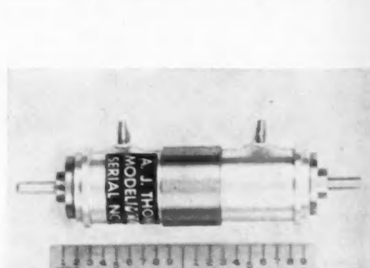

Compact Duplex Clutch

Double input with single output shaft is featured in a line of miniature duplex electro-magnetic clutches. The units are ideally suited for use as speed or direction changers in servo type applications. High performance is coupled with small size, minimum weight and fast response time. Units operate on DC voltage and no slip rings are required. Autotronics, Inc., Route 1, Box 812, Florissant Mo.

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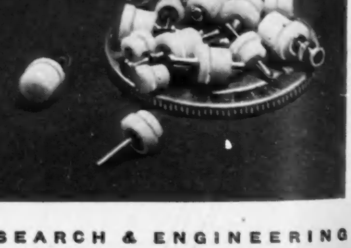

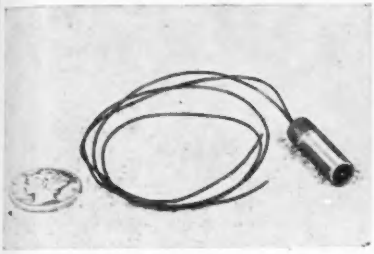

Minute Magnetic Pickup

Providing minimum weight and size with maximum voltage output, this sub-miniature pickup is about the diameter of a pencil eraser. Weighing approximately 4 grams, the pickup is a highly compact, sensitive transducer which translates the movement of ferrous objects into a variable and measurable AC voltage. The output, proportionate to the rate of the object's movement, provides an extremely accurate mechanical-electrical transfer of energy which can indicate motion, torque, RPM, vibrations; actuate electronic counters, synchronize machinery, control circuits, and provide data for telemetering missiles and aircraft. Electro Products Labs., Inc., 4501 N. Ravenswood Ave., Chicago 40, Ill.

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Pygmy Potentiometers

Sub-miniature, precision wire-wound trimming potentiometers with tabs especially for printed circuit applications, these new Acetrims have all the features of regular ½" precision trimmers, with round or flat tabs in place of terminals, to facilitate assembly with other circuit elements. Specifications include: ½" size; weight ¼ oz.; 10 ohms to 150K resistance; power 2 W @ 60°C maximum; Temperature —55°C to 125°C; sealed, moisture-proofed, anti-fungus treated; withstands severe shock, vibration, acceleration; meets applicable Military specifications. Ace Electronics Assoc., Inc., 103 Dover St., Somerville 44, Mass.

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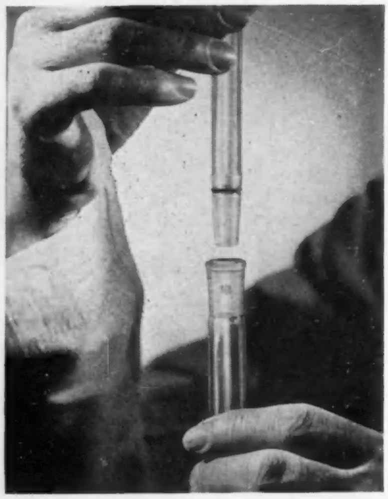

Improved Taper Joints

Standard taper conical joints with built-in rubber O-rings are made of highest quality borosilicate glass, completely fusible and compatible with Pyrex and other borosilicate glass tubing. The O-ring, which may be removed, allows leak-proof glass construction and permits assembly of glass apparatus which is leak-proof at high vacuums—up to 10^{-8} mm. They completely eliminate the need for high-vacuum greases and permit freedom from atmospheric contamination of the system. The rubber O-ring is effective for work up to temperatures of 300°F., and silicone O-rings are available on special order for work at higher temperature. Construction of the joints is such that the O-ring is protected from the action of attacking solvents by the ground tapered surface of the joints themselves. Arthur F. Smith Co., 311 Alexander St., Rochester 4, N.Y.

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Alpha Survey Meter

A new portable survey instrument for alpha surface contamination measurement, consists of an unsealed air proportional alpha probe connected by means of a cable to a battery-operated count rate meter. The meter provides three ranges of 0-150, 0-1500 and 0-15,000 count-per-minute. The counting chamber of the alpha probe has an active area of 75 sq. cm. and a window thickness of approximately 0.8 mg/cm^2. With its use the count rate unit will measure alpha contamination from a minimum of 2 alphas per cm^2/minute to 2000 alphas per cm^2/minute. Designated as Model AP4, the probe is ideally suited for use with standard a.c. operated quarter-volt scalers or ratemeters, and may be ordered separately for this purpose if desired. No modification of the probe is necessary. Nuclear Chicago Corp., 229 W. Erie St., Chicago 10, Ill.

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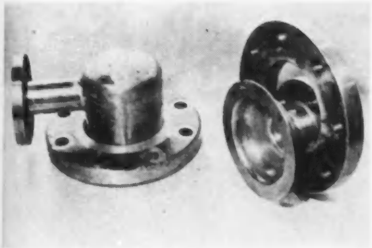
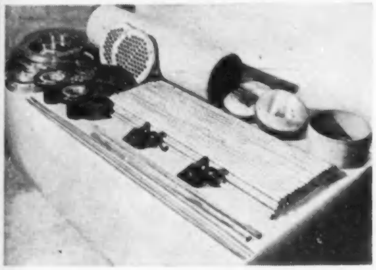
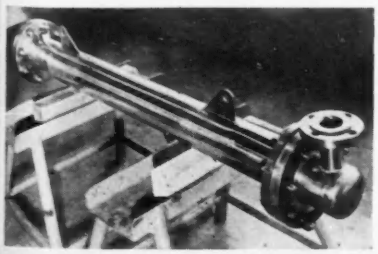


Standard Exchanger Parts

Ability to buy a specific heat exchanger on an "off the shelf" basis can result in considerable savings in terms of time and custom design costs. A complete line of single and double-pass carbon shell heat exchangers is now available on a two-weeks delivery basis. The flexibility of this standardized equipment makes it possible to solve the majority of heat exchanger problems without the need for special designs, while still adhering to



ASME and TEMA code construction. Many combinations of diameter and length are available, and the number of passes can be varied according to specifications. Flange nozzles or couplings can be installed in any position, and shell and side baffles can be spaced as desired. Standard shell diameters range from 4½" to 20". Units are designed for 75 psi tube pressure and 150 psi shell side pressure up to 300° F. The Pfaudler Co., 1036 West Ave., Rochester, N.Y.



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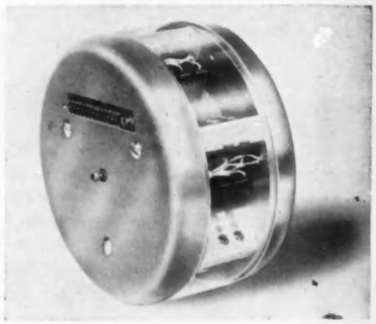
Lab Equipment

Memory Drum

Over 12,000 bits of data and associated clock reference information can be stored in this new miniaturized, magnetic memory drum. The device may be incorporated in data handling systems and computer systems or utilized as a laboratory testing instrument. The standard laboratory drum measures 3½" diameter and contains 12 information channels plus clock and fiducial channels. Each channel is 0.70" wide with a capacity of 1024 bits. The drum is belt-driven with variable speeds to 15,000 rpm. Access time is approximately 1.25 milliseconds. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.



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Resin Reaction Apparatus

Use of a new plate design makes it possible to employ round bottom flasks of 8500 to 33,000 ml. capacity in a resin reaction apparatus, which prior to this development could only accommodate 5000 ml. round bottom flasks. The ¾-inch thick cover plate, made of Pyrex brand glass has five standard taper joints to receive a condenser, thermometer, stuffing box with heavy-duty stirrer, separatory funnel and gas inlet tube. Since the entire unit is made of Pyrex glass, except for stand and clamping assembly, full observation is permitted at all times. The apparatus is ruggedly constructed and easy to assemble. A heating mantle can be supplied. Scientific Glass Apparatus Co., Inc., Bloomfield, N.J.

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Ignition Apparatus

An ignition apparatus has been developed for determination of S.I. Temperature of plastics and other solids; and for evaluation and classification of any combustible or non-combustible materials. The Setchkin Ignition Apparatus for Solids can also be used for research on ignition and combustion processes. Custom Scientific Instruments, Kearny, N.J.

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DEVELOPMENTS

(Continued from page 8)

Academy of Sciences. Dr. Gunn reported that investigations indicate a relationship between the cleanliness of air and the likelihood of rain, and he warned that air contamination caused by smokestacks and atomic bomb explosions may slow the formation of rain. His conclusions were based on studies made with a large, artificial cloud chamber operated by the Weather Bureau at Hitchcock, Texas.

Dr. Gunn stressed that he was not contending that atomic blasts to date had altered weather conditions. The Academy itself had reported last year that it found no conclusive evidence along this line. The weather expert noted that the answer to this question involves numerous variables and a qualitative determination of how much atomic dust has been cast into the atmosphere.

However, his investigations indicated that the dirtier the air became the more difficult it was for rain droplets to form and to grow big enough to fall. "If you dump enough junk into the air, it is going to decrease the initiation of rain," he said. Dr. Gunn predicted that the only way we will be able to solve the future air pollution problem will be with "atomic power which does not dump ash and other matter into the air.

Fish Flour for the Masses

A low cost, high quality protein that could aid in controlling chronic starvation in many of the world's underdeveloped areas may soon be available, in view of plans to build a fish flour producing plant at New Bedford, Mass. The factory, the first of its kind anywhere, will be designed and built by Blaw-Knox Company, Chemical Plants Division, in collaboration with the VioBin Corporation, a firm which has developed special techniques for making a superior grade of fish meal.

Fish flour is said to be tasteless and odorless, of high nutritive value, and of far lower cost than any other form high quality protein. It can be used as an additive in foods and pharmaceuticals. It is also said to be the first stabilized and deodorized product of high biological value ever produced for human consumption.

Advertising Index

Latest on Lithium 80

Lithium metal dispersions have unique properties as polymerization catalysts.

Lithium Corp. of America, Inc., 2697 Rand Tower, Minneapolis 2, Minn.

Non-Corroding Refractories 81

These refractories are proving superior in numerous corrosive applications.

Carborundum Co., Dept. 557, Perth Amboy, N.J.

A Gram or a Carload 82

Rare earths are available for prompt shipment in any quantities desired.

Lindsay Chemical Co., 274 Ann St., West Chicago, Ill.

Analysis Microphones 83

The 21BR series have proven fully acceptable in high intensity sound measurement.

Altec Lansing Corp., Dept of Advanced Engineering, 1515 S. Manchester, Anaheim, Calif.

Electronic Grade Chemicals 84

Impurities are reduced to new lows in these compounds for semiconductors.

Baker & Adamson, General Chemical Div., Allied Chemical & Dye Corp., 40 Rector St., N.Y.C. 6

Compact Connector Unit 85

Single or multiple Unilok is half the size and weight of usual AN connectors.

Burndy Corp., Norwalk, Conn.

Short-Order Charts 86

Special strip and circular charts can be produced quickly to your specifications.

The Bristol Co., Waterbury 20, Conn.

Optical Bargains 87

Over 1000 items of every type of optical device are listed in this big catalog.

Edmund Scientific Co., Barrington, N.J.

Getting Things Done 88

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Graphic Systems, 55 W. 42nd St., N.Y.C. 36

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Leco Zirconia ware for temperatures up to 4600° F is also chemically inert.

Laboratory Equipment Corp., 5005 Hilltop Rd., St. Joseph, Mich.

Assembly Costs Cut 90

Quickupl stainless steel pipe fittings need no threading, welding or flaring.

Vanton Pump & Eqpt. Corp., Hillside, N.J.

Special Transformers 91

This firm is experienced in designing transformers to difficult specifications.

Peerless Electrical Products Div of Altec Lansing Corp., 1515 S. Manchester, Anaheim, Calif.

Safety-Packed Solvents 92

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Fisher Scientific, 115 Fisher Bldg., Pittsburgh, Pa

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Tektronix, Inc., P.O. Box 831, Portland 7, Ore.

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Lab Eqpt. Div., Lindberg Engineering Co., 2489 W. Hubbard St., Chicago 12, Ill.

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This stereoscopic binocular is suited fo industrial inspections and examinations

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Evans Research & Development Corp., Dept. R 250 E. 43rd St., New York 17, N.Y.

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